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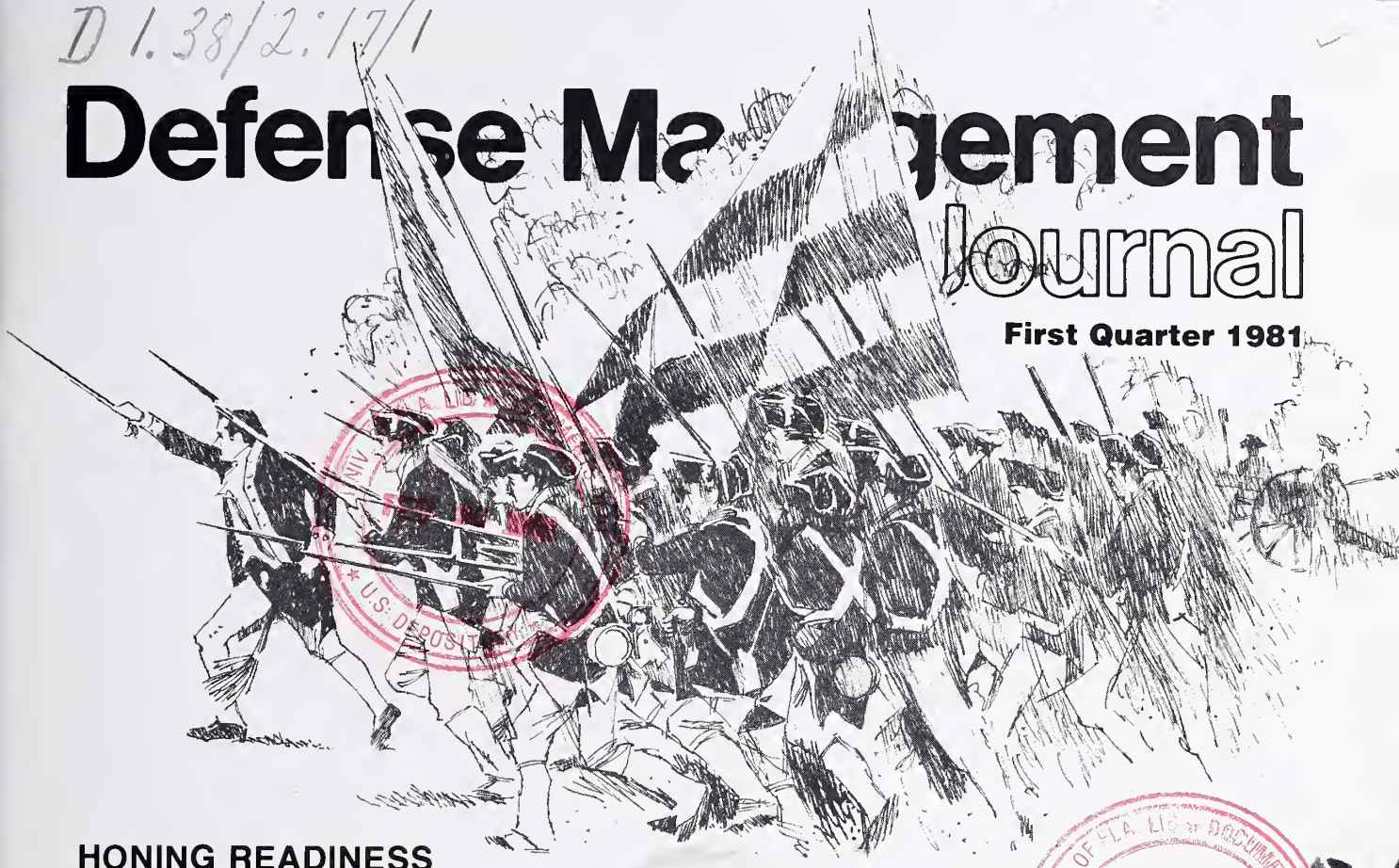

HONING READINESS THROUGH RESEARCH

in brief

FRONT COVER BY HUGH BROWN
BACK COVER BY BOB GEORGE

The *Defense Management Journal* is a quarterly publication of the Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics). As a forum for the interchange of ideas, the *DMJ* publishes articles on current defense policies and on methods for improving defense management. Unless otherwise stated, the views herein are those of the authors and are not necessarily those of the Department of Defense or any of its elements.

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editor's page

Readiness in 3-D

For better or for worse, the government has long displayed a penchant for doing things in triplicate. Well, we at the *DMJ* have gotten in sync with our government colleagues and submitted to the triplicity syndrome. And although it's been said that conformity is the bane of small minds, we hope you, the readers, will see the wisdom of our ways.

This issue of the *Defense Management Journal* is the first of three consecutive ones that will spotlight the salient issues surrounding our current state of military readiness. Certainly no aspect of our present military posture is more crucial or deserving of such wholesale coverage.

Inside this issue of *DMJ* you will find articles that address emerging concepts of readiness measurement as well as a timely and insightful interview with the Deputy Assistant Secretary of Defense for Requirements, Resources and Analysis. Featured in the forthcoming issue will be the rapid deployment force and the state of materiel availability and maintainability. It will also contain photographs and biographical profiles of newly appointed members of the Defense hierarchy. The final sequel in our readiness series, Third Quarter 1981, will highlight the readiness assets and liabilities of the reserve components.

Of course, all three issues will also contain the usual *DMJ* departments as well as feature articles on subjects outside the readiness sphere.

We will change direction in the Fourth Quarter 1981 issue, which will examine some interesting facets of small and minority-owned business policies and programs. This area of defense management is steadily attracting greater attention and promises to be highly visible in the next few years. The deadline for submitting manuscripts on this topic is July 1.

Getting into Focus

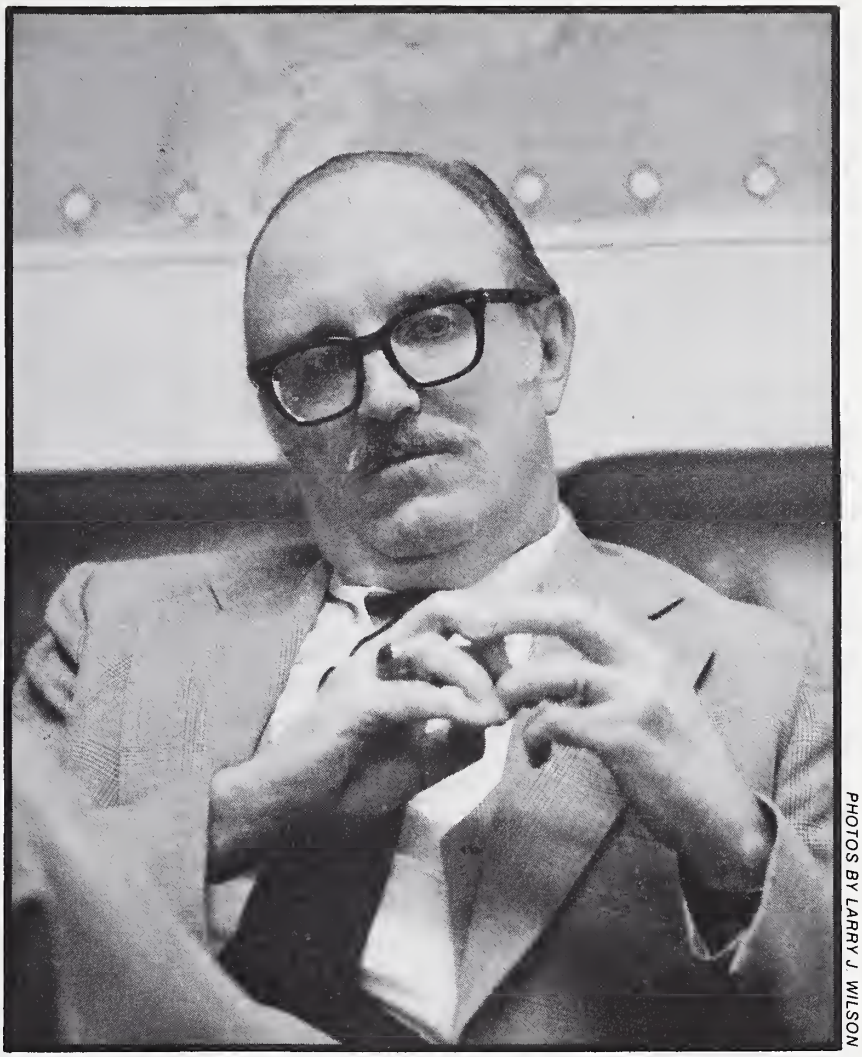
After nearly a year of planning and preparation, the staff of the *DMJ* will begin publishing the *Defense Management Research Focus* this autumn. *Focus* will be a semiannual, juried publication. Each issue will be devoted exclusively to a single policy area within DoD. The inaugural edition will focus on military personnel attrition, with emphasis on first-term enlisted attrition. Manuscripts for this first issue are being accepted and should be submitted to the *DMJ* office no later than May 1. We are in the process of selecting jurors for manuscripts submitted for publication in *Focus*. Anyone interested in serving as a juror should contact the *DMJ*.

Clearly, the mission of editing and producing two professional journals accentuates our continuing responsibility to publish articles that are of value and interest to you. In this respect, we remain most receptive to articles and ideas from our readers, for if communication is to be truly effective, it must flow two ways. This is especially important to us since effective communication is the cornerstone of effective management.

The daily demands of readiness

An interview with Charles W. Groover, Deputy Assistant Secretary of Defense (Requirements, Resources and Analysis)

Interview by Thomas J. Gelli, *DMJ* Managing Editor



PHOTOS BY LARRY J. WILSON

DMJ. ***There seems to be a surprising amount of confusion about what is really meant by military readiness. Can you give us a working definition?***

Groover. I'll try. First, let me say that much of this confusion stems from the tendency to equate readiness with capability. In our efforts to analyze and address the readiness problem, we refer to our ability to prevail in any engagement, campaign, or conflict as our combat capability. This ability to prevail in conflict is naturally our highest objective. Readiness, then, is just one of four components that determine that overall combat capability. The others are force levels, extent of modernization, and sustainability. Within this framework, we define readiness as the ability of a force, unit, weapon system, or equipment to perform the specific function or functions for which it was designed, organized, or equipped. In this context, readiness is unrelated to the size of the force structure or rate of modernization. For example, an air force that consisted of only two wings of F-100s could be said to be completely ready, yet be quite incapable of meeting the threat.

DMJ. ***In a recent article, you cited a pressing need to quantify the link between resources input and achieved readiness. Is progress being made in this area?***

Groover. Absolutely. First of all, each of the services, particularly the Air Force, is actively developing analytical tools that will allow managers to better define the relationship between resources input, in terms of dollars and skilled manpower, and the readiness that results. Concurrently, we in OSD are sponsoring several complementary research efforts that are expected to provide the kinds of tools most appropriate and useful at our level. For example, the Logistics Management Institute, under our sponsorship, is developing a model that describes aircraft materiel-readiness outputs in terms of

the number of wartime aircraft sorties that can be flown as a function of time for a given set of resource inputs. Such a mechanism will allow our analysts to see how feasible wartime sortie profiles change as a function of money spent in peacetime on spares, maintenance, and skilled manpower. We are also sponsoring a Rand Corporation effort to modify a tactical air-force model so as to allow our analysts to assess the readiness of land combat units in terms of the number of actions—for example, the number of unit attacks per day that could be mounted as a function of resource inputs.

DMJ. ***What do you see as DoD's most critical readiness problems?***

Groover. Within our working definition of readiness, there are four major problem areas that come to mind. Certainly, the foremost one is personnel. In terms of raw numbers, Army Reserve and Army National Guard units are experiencing shortfalls in unit manning. Let me add, though, that unit strengths in the other reserve components are at authorized levels. In the active forces, the problem today is not so much one of accessions, but rather retention, or more specifically, the loss of experienced personnel. All services, especially the Army and Navy, are having a difficult time retaining middle-grade noncommissioned officers. It is a problem that clearly is having a serious, adverse impact on the enlisted middle-management corps.

The second critical problem area is the current inadequacy of Army equipment inventory levels, a problem that stems from our expansion of the Army to 16 active divisions and the addition of heavy units—that is, armored and mechanized infantry—while simultaneously pre-positioning more Army equipment in Europe to enhance our rapid reinforcement capability. We refer to this pre-positioning as POMCUS, pre-positioning of materiel configured in unit sets.

Now, I happen to think these initiatives are fully justified by the threats we face in Europe and elsewhere. However, this expansion of POMCUS, coupled with an expanded and heavier force structure, has increased the demand for Army equipment faster than the funds have been available to procure the equipment. As a result, Army equipment inventories are clearly spread too thin. This is reflected in levels of equipage in stateside Army Reserve units, and it restricts the level of war-reserve equipment inventories in places like Europe.

Another significant readiness problem, as I see it, is a shortfall of war-reserve spare weapons components, especially for our strategic airlift aircraft, namely the C5 and C141. In wartime, these two airlifters would see utilization several times greater than in peacetime. Consequently, we are seriously concerned that today's war-reserve spares inventory may be insufficient to support these aircraft at the higher wartime utilization rates for the length of time some potential emergencies might require.

The last major problem area that should be mentioned is that of war-reserve munitions stock levels. First, let me preface this by saying that in terms of gross tonnage we have generally adequate stockpiles of the older, conventional munitions. However, the last 10 or 15 years have seen dramatic developments in munitions effectiveness. As you know, we now are producing laser-guided munitions, electro-optical guided munitions, and the improved conventional munitions, or ICM, to name but a few. These technological advances often combine more lethal area per pound delivered and greatly improved delivery accuracy for a dramatic increase in effectiveness per sortie or per volley. And while these munitions are vastly more effective than the ones previously stockpiled, they are also significantly more expensive. As you might expect, these higher unit costs, among some other considerations, keep us from building our war-reserve inventories of these modern, much more effective munitions as rapidly as we would like.

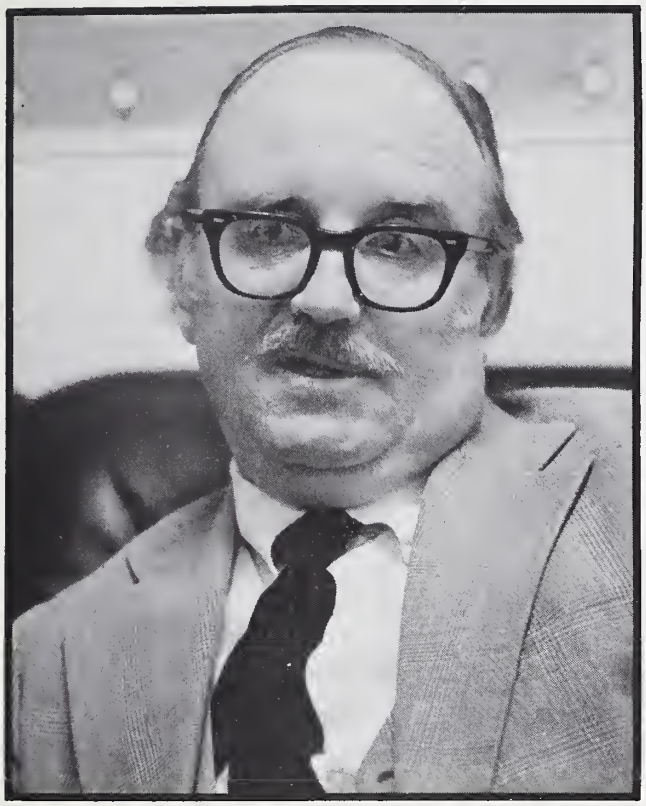
DMJ. ***What is being done to remedy these problems?***

Groover. We are addressing each of them. For example, with a helpful assist from the Congress, the recent 11.7-percent across-the-board military pay raise, the newly instituted variable housing allowance, and significant increases in carrier sea pay, including for the first time carrier sea pay for officers, and in submarine duty pay should start to help solve our active-duty personnel problems. So should the less-publicized but extremely important initiatives like the recent increases in travel allowances and reimbursements. Perhaps most importantly, these initiatives manifest a new willingness on the part of the United States to provide fair and adequate financial compensation to its military.

Also, both the FY81 and FY82 budgets reflect significant increases for aircraft spares procurement. In fact, the Air Force's FY82 budget request for aircraft spares procurement is more than a billion dollars higher than in FY81. A significant part of this increase is designed to fill the C5 war-reserve deficiencies I mentioned a moment ago.

We are also budgeting and programming substantial munitions procurement funds that will steadily improve our modern war-reserve munitions posture over the next few years.

Let me retrogress and briefly expand my comments beyond my previously established definition of readiness to touch on a specific force and modernization issue. Ready forces aren't worth much if you can't put them where you need them. Today, we clearly have some shortfalls in our strategic-mobility capability that



would limit our ability to move substantial forces quickly, over great distances, into remote but strategically critical areas. Congress is now considering DoD proposals to increase our strategic airlift capability, to acquire some fast sealift with a vehicle roll-on and roll-off capability, and to buy a fleet of ships that could be used to pre-position land-force equipment, supplies, and munitions in some of those remote areas such as the Persian Gulf, thereby reducing the demand for fast lift early in a contingency. These three initiatives are being sized and designed to complement one another and to give us the kind of mobility and flexibility we need. They are absolutely essential, and when available, will vastly improve our ability to deploy and sustain forces in remote locations.

DMJ. ***A moment ago, you seemed to suggest a growing concern about the level of war reserves. How responsive have our allies been to encouragement from us to bolster their war reserves?***

Groover. That's a thorny question. For at least the last decade that I know of, the U.S. war-reserve munitions posture in Europe has been significantly better than that of our European allies. However, we have been strongly encouraging our allies to close that gap. We have received commitments from them to shore up their war-reserve posture and we expect them to attain certain reasonable, interim objectives by the middle 1980s. Nevertheless, we must and will continue to press the allies to improve their ability to sustain their forces in combat.

DMJ. ***What are the logistics implications that arise from the strategic-mobility and personnel shortfalls you've mentioned?***

Groover. Because of those and other factors, we clearly have to look to the host nations. In the case of NATO, that means our western European allies, including the British, will provide certain essential logistics support for our combat forces. Today's U.S. military support structure, when coupled with existing host-nation support agreements, could not provide the full range and depth of support that might be needed to sustain our combat forces in Europe during a time of crisis. However, we now have negotiations underway with Germany, the United Kingdom, and the three Benelux nations. We expect these negotiations to lead to specific agreements whereby those countries will provide specified quantities of logistics support, under specified circumstances, during specific time periods after the onset of an emergency.

DMJ. ***Today, a significant portion of logistics support in DoD is being provided by contractors. What impact, if any, does this have on our readiness posture?***

Groover. It's true that contractors provide DoD many different kinds of logistics support in many different locations. We use a lot of contractor support for depot maintenance. In fact, we make a conscious effort to place a large fraction of our total depot-maintenance workload in the private sector. By awarding certain maintenance work to the private sector, DoD indirectly expands the industrial base and thus enhances its mobilization capability. So in this sense, the use of contractor support strengthens our readiness posture.

DMJ. ***What about the use of contractor support in prospective combat theaters?***

Groover. We do have contractor support in Europe. From what I've seen, I think these contractors would continue to perform well for us in wartime. Admittedly, there has been some uncertainty expressed about how contractor personnel and DoD civilians might react when the shooting starts. However, we are looking at this problem and think we have some ideas about how to reduce those risks.

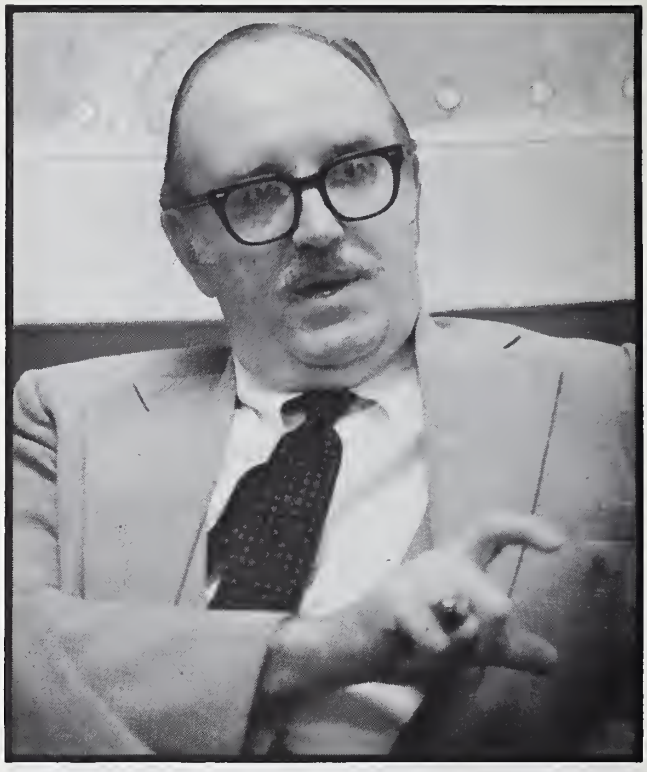
One other potentially negative effect of the use of contractor support may occur where we have attempted to minimize peacetime support costs in theater by using contractors in a way that inadvertently reduces the readiness of military maintenance organizations. In

other words, in some instances reliance on in-theater contractor support may have taken away from the proficiency of military maintenance units we would have to depend on in wartime. We must continually ensure that our desire to do something efficiently and cost-effectively in peacetime does not degrade our ability to fight.

DMJ. ***Support is one thing, production another. Does American industry have a strong commitment to expand its production base in time of war?***

Groover. I think so. I have no doubt about American industry's commitment and willingness to satisfy wartime military requirements when the national interest is unambiguously threatened. However, to many, the circumstances apparently were not unambiguous during the Vietnam effort and some firms were unwilling to forego some of their civilian business in order to produce for the military. Still, I remain confident that a clear threat to the national interest would spur American industry to satisfy the military's needs to the fullest extent possible.

However, it is important to keep in mind that willingness and capability are not synonymous, and there is valid cause for concern about the ability of certain segments of the industrial base to expand to wartime levels.



DMJ. ***Are you referring to munitions production?***

Groover. Certainly that's a part of it, but it's better to analyze the industrial-base issue in broader terms. First of all, DoD has made a conscious decision *not* to make substantial peacetime investments in production capacity over and above what is needed for peacetime procurement. You see, even large expenditures to increase the capacity and responsiveness of the production base do not really create a base that can respond instantaneously. Consequently, in light of our prevailing sustainability posture, it seemed wiser to apply most of our sustainability investments to procure war-reserve munitions, spares, and equipment to flesh out our very early wartime sustainability, than to invest now in a larger production base whose yield could not be expected to help us for several months after the balloon went up.

DMJ. ***Isn't anything being done to strengthen the military industrial base?***

Groover. Yes. I didn't mean to give the impression that we are neglecting this facet of readiness. The people in the Office of the Under Secretary of Defense for Research and Engineering have developed and are developing initiatives that should provide incentives for production-base investment in the private sector. I believe that office is looking closely at multiyear contracting, tax-policy revisions, and incentives that would boost expenditures on manufacturing technology programs. It also is attempting to revamp the industrial preparedness planning process so that DoD can obtain more reliable and relevant data on industry's actual capability to satisfy military requirements.

Let me add that DoD also works with the Federal Emergency Management Agency and the other involved federal departments and agencies to try to reduce our vulnerability to an interruption in the availability of certain critical raw materials that now must be imported.

DMJ. ***Have stipulations that a certain percentage of subcontracts be awarded to small and minority-owned businesses had any negative impact on our industrial base?***

Groover. No, in general, I don't think so. However, there are some special cases where problems may arise. For example, where a large contractor develops a specific item which then becomes 100-percent set-aside for small or minority-owned businesses, the large contractor is precluded from bidding on the production contract. Consequently, the large contractor's production base for that item generally dissolves, thus reducing the overall wartime expansion capability for that item. I think these situations are pretty rare, and for the most part set-aside stipulations do not have a significant adverse impact on defense industrial preparedness.

DMJ. ***Since FY77, the percentage of recruits that have***

scored in Category IV on the military entrance exam has been on the rise for every service. How does this fact, coupled with the increasing complexity and sophistication of military hardware, affect our readiness posture?

Groover. Increased equipment complexity does not necessarily translate into a more complex job for the basic-level maintenance personnel. However, at some level of the maintenance organization, this increased complexity presents the maintenance supervisor or skilled technician with a much more demanding challenge.

We are acutely aware of the critical importance of acquiring and retaining sufficient numbers of personnel who possess the right skills and aptitudes to operate and maintain the more complex modern systems that will continue to enter our inventories in increasing numbers. Certainly, the average experience level of our maintenance supervisors has been declining as a result of the retention problems and some other factors. Logic tells us that as the nation's demographic trends present a smaller military-age population and as the private-sector employment picture brightens, it's bound to get even tougher to acquire and retain the kind of personnel we need.

DMJ. ***Is there a solution?***

Groover. Well obviously there's no simple remedy. Adequate compensation is requisite to a solution. As we've already discussed, we've recently made some real progress there. However, it would be a terrible mistake to think that solved the problem. We must continue to look at the best way to use and size enlistment and selective reenlistment bonuses. Continuation of quality-of-life improvements or whatever else is necessary to make military life attractive to prospective and current service members in the all-volunteer environment is also essential.

Now, having said all that, let me say that if the Executive and Legislative branches of the government and the American people are unwilling to pay the financial price to make the all-volunteer force work as we enter a period of a smaller recruiting pool, a brighter civil-sector employment picture, and a steadily growing DoD demand for people with adequate educational foundations and technical aptitudes—and I think the financial price will be very substantial—then this country may have to give serious consideration to a return to the draft. And I say that knowing how very unattractive that prospect is to many sectors of our society.

DMJ. ***What have mobilization exercises like Nifty Nugget and the recently conducted Proud Spirit told us?***

Groover. Both were very valuable in teaching us about weaknesses in the procedural aspects of mobilization, but neither exercise told us much that we didn't already know about such things as the levels of war-reserve munitions and equipment in Europe. I suppose the exercises dramatized the implications of certain shortfalls, but they really didn't uncover any surprises. People outside the walls of the Pentagon tend to misunderstand the basic purpose and chief value of these exercises. I think the exercises have both been extraordinarily valuable for what they have taught us about the process of mobilization, including what decisions need to be made when, what kind of information is needed to make them, the accessibility and level of detail of information, and what decisions should be made at what levels. We learned a lot about the kinds of computer-based planning and information systems we need, and in a few cases, something about the deficiencies and inflexibilities in some of the computer-based planning systems we do have.

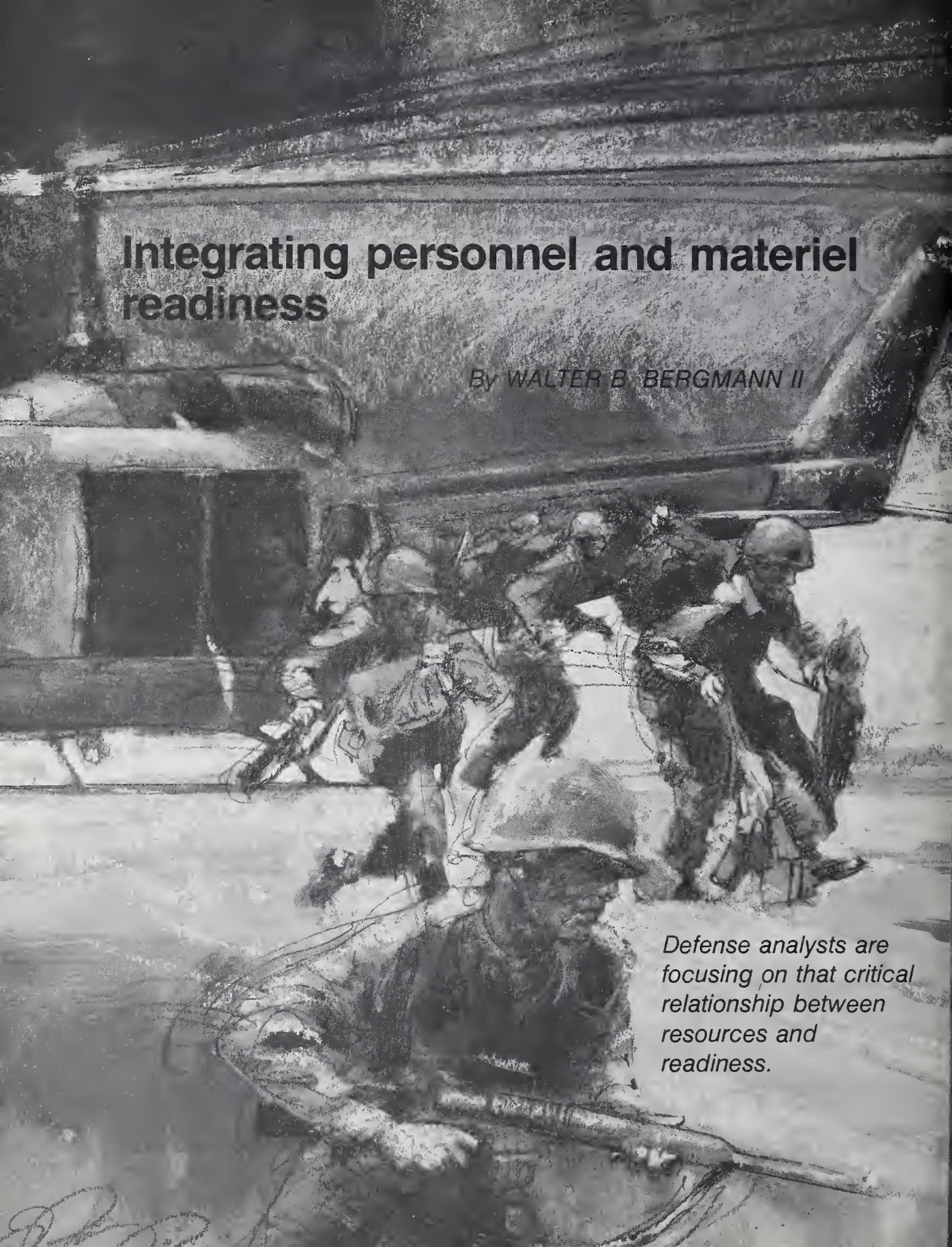
Let me add that there's a tendency to overplay the readiness implications of these kinds of mobilization exercises. These exercises should be viewed as learning exercises and not readiness assessments.

DMJ. ***Are we seeing a philosophical shift in DoD regarding readiness?***

Groover. Yes, and that is clearly evidenced by recent trends in resource allocations. Up until about 1970, DoD planning focused on the size of the force structure and rates of modernization. This philosophy was based on the implicit assumption that in time of crisis, readiness could be quickly enhanced with a sudden infusion of resources. This caused trouble. For example, in determining allocations for war-reserve munitions procurement, some planners argued that money had to be spent first on items with the longest procurement lead times. The idea was to buy the airplanes and ships new and worry about the ammo later. Now, while it's true that a major capital ship or airplane has a much longer lead time than the time required to expand munitions production, it's also irrelevant. Today, the length of strategic warning time that we can safely count on is very short, shorter than the shortest procurement lead time. Consequently, I think, or at least I hope, most of us have become convinced that we must maintain a peacetime posture that will permit us transition to the required wartime posture within this limited warning period. And since the warning period we can safely count on is fairly short, it is necessary to maintain a rather high level of day-to-day peacetime readiness. This presents us with a real challenge, particularly in light of the fact that those elements of readiness that hinge on training are highly perishable. However, it is a challenge that we must meet. DMJ

Integrating personnel and materiel readiness

By WALTER B. BERGMANN II



Defense analysts are focusing on that critical relationship between resources and readiness.

Fighting wars to determine the ability of units to perform their designated wartime missions is obviously impractical and imprudent. Consequently, the Department of Defense uses a combination of readiness reporting and field-evaluation exercises to quantify the mission readiness of units. Field evaluations are conducted no more than once a year and serve to verify reported readiness.

The 1978 Defense Authorization Act required DoD to submit an annual report describing the projected impact of requested appropriations on materiel readiness. In attempting to respond to this requirement, DoD realized that existing procedures for measuring combat-oriented readiness were not suited to the task since the primary purpose of the Joint Chiefs of Staff readiness reporting system was determination of the ability of each unit to carry out its wartime mission with its on-hand assets. This spurred DoD to devise ways of measuring materiel readiness as a function of available lead time and on-hand resources. Because the 1978 authorization act specified materiel readiness, DoD's efforts focused on analysis and management of materiel resources, including spare and replacement parts.

But the 1981 Defense Authorization Act calls for an annual projection of unit personnel readiness that is likely to result from the funding proposed in the president's budget. This new requirement will give rise to an effort in the area of personnel resources similar to the ongoing effort in the area of materiel resources.

There are two interrelated aspects of readiness measurement. The first is criteria, or the desired readiness objectives in the context of a unit's mission; the second is indicators, or a statement of the readiness that is achievable with a set of resources. The availability-for-combat orientation of the JCS readiness reporting system focuses on indicators that describe status against a criterion—the probability that a weapon system or unit is ready to perform its assigned mission with little or no notice at any random point in time. Such an approach does not lend itself to analysis of the time-dependent impact of resources on mission accomplishment. Consequently, DoD has been devoting considerable effort to identifying appropriate dynamic, output-oriented, quantifiable readiness criteria, such as the number of attacks that could be generated over time. In parallel, DoD also has been devoting considerable effort to identifying and analyzing materiel indicators that can be related as a function of lead time and resources to the probability of satisfying these new readiness criteria.

Unit readiness reporting is based on personnel readiness indicators and materiel readiness indicators.[1] Although personnel readiness and materiel readiness are typically measured and assessed as independent parameters, they are inextricably interdependent (see figure). In the figure, only operators and maintainers are assumed to be critical to satisfying the unit's readiness criteria. This, of course, is an oversimplification made solely for clarity of presentation. Obviously, other occupational specialties such as supply clerks, medics, and cooks are also essential to maintaining unit readiness.

One implication of this relationship is that a unit may possess the required number of equipment operators, but the operators may not be able to complete required unit training because equipment is nonoperational. Consequently, they fail to become proficient in their wartime tasks. On the other hand, equipment may be nonoperational due to a lack of replacement parts or because it is awaiting maintenance. Down time can also be a symptom of insufficient numbers of fully qualified maintenance personnel. This situation may stem from a shortage of maintainers in the unit or from an inadequate opportunity to provide necessary on-the-job training to assigned apprentices.

The areas that can be directly measured, at least theoretically, are denoted by ovals in the figure (see p. 10). These are primary-level readiness indicators and they must be incorporated with intermediate-level indicators (denoted by hexagons) and with composite indicators (denoted by rectangles) to provide a comprehensive picture of a unit's readiness.

The relationships in the figure illustrate that the various parameters that affect unit readiness are interdependent. To reflect this interdependence in readiness measures, analysts must embrace the concept of intermediate-level readiness indicators and a new approach for transforming primary-level readiness indicators into composite indicators.

Under current procedures, the lowest rating of any of the primary-level readiness indicators is re-

[1] *The JCS combat readiness reporting system contains four indicators—personnel, training, equipment and supplies on hand, and equipment readiness. The terms in this article are generic and are not intended to describe existing specific measures of readiness.*

ILLUSTRATION BY JACK PARDUE

garded as the unit's readiness rating. However, it is possible to offset the impact of manning shortages by assigning only skilled people, a move that does not necessarily lead to a degradation of unit readiness. On the other hand, manning shortages coupled with a substandard proficiency mix degrade unit readiness more than the parameters standing alone would indicate. Consequently, analysts need to devise judicious ways to integrate primary-level personnel indicators with intermediate-level and composite personnel indicators. Further, it is necessary to better understand the synergism between personnel and materiel parameters so that methods for analytically relating the effects of various levels and mixes of personnel and materiel resources can be formulated.

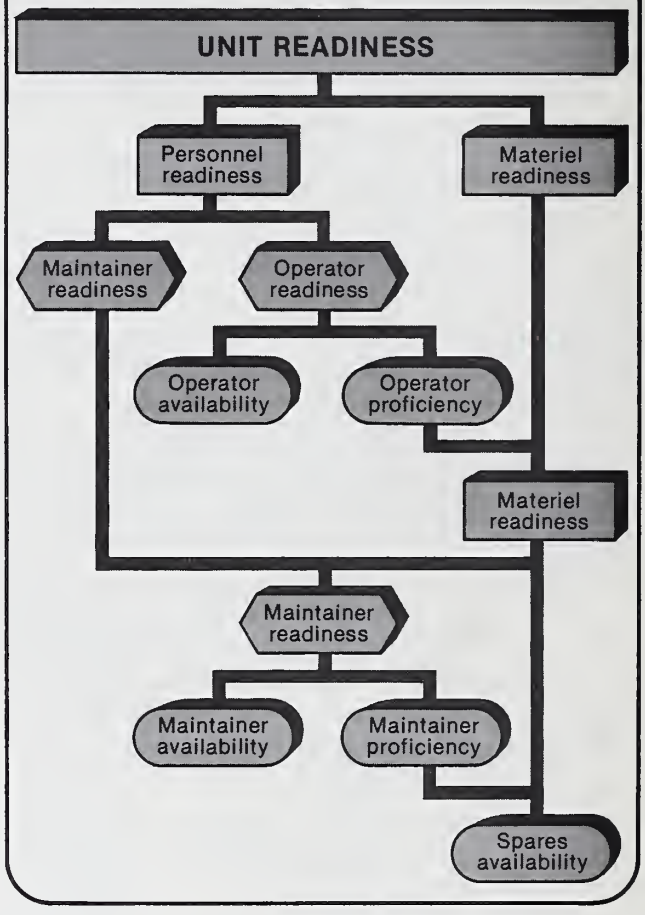
Nonetheless, if DoD is to comply with the intent of the 1981 Defense Authorization Act, it must go beyond simply devising ways of combining personnel and materiel indicators. It must also develop personnel indicators that are compatible with the new materiel indicators. To fully appreciate the complexity of this task, one must explore the considerations relevant to relating personnel resources to the dynamic readiness criteria being developed.

The traditional indicators used for measuring personnel readiness have been the percent of authorized strength actually available and the percent of assigned personnel possessing the occupational skill level stipulated by the unit manning document. The obvious shortfall of these indicators is their inability to convey adequate information on the criticality of vacancies or on the impact of the skill proficiency of assigned personnel.

To identify the mission criticality of vacancies, one must be able to identify the type of jobs not being filled. Each service has manpower information systems that are separate from the readiness reporting systems and that permit assessment of shortages by occupation within a major command. To date, though, only the Air Force and the Navy have incorporated this capability into unit readiness reporting. In contrast, the Army and Marine Corps assess shortages by occupation per the "commander's judgment" provision of the Unit Reporting system.

The critical relationship of vacancies to unit readiness is not obvious from a comparison of the number of authorized personnel against the number of assigned personnel for any given occupation in a unit. For example, a unit may be without certain key

A simplified view of the interdependence of various parameters that affect unit readiness



administrative personnel. While this clearly puts a burden on other unit personnel and could result in bungled personnel or payroll records, it is unlikely that it would negate, at least in the short run, the unit's ability to achieve its readiness criteria. Thus, it is necessary to devise readiness indicators that reflect assignment problems as well as personnel shortages that degrade the unit's ability to accomplish its wartime mission. Ultimately, it will be necessary to quantify the resulting unit-readiness degradation.

A critical consideration in the quest for new readiness criteria and indicators is timing. Timing encompasses two dimensions: the length of time that a unit is expected to produce output at wartime rates before being resupplied with people and materiel, and the length of time expected to be available for improving a unit's materiel and manpower status.

The latter dimension is the length of time between when a decision to mobilize is made and when the unit is expected to begin producing at wartime rates. The former dimension must be embodied in the criteria, the latter in the indicators.

To respond to the congressional mandate to relate the resources in the president's budget to expected unit readiness, DoD must devise a means of adjusting or annotating the personnel indicators that are reported by a unit so that these indicators take into account all personnel who could be assigned to a unit before its deployment or engagement with the enemy. These personnel include transients, students, members of the Individual Ready Reserve, and members of nondeploying units. It is also necessary to implement personnel management systems that facilitate rapid recall and reassignment of personnel.

In addition to needing indicators that reflect the potential mission degradation from personnel vacancies, analysts need indicators of the proficiency of assigned personnel. Examination of the fill rate by occupation fails to reveal potentially serious experience imbalances. For example, a shortage of enlisted journeymen can be and often is offset by assigning more apprentices than are called for in the unit manning document. This approach provides the unit commander with the needed number of graduates from specific formal training courses to meet requirements for a given occupation. However, it must be kept in mind that formal classroom training in all of the services provides only a part of the knowledge needed to be proficient in an occupation. Most equipment-specific skill proficiency must be acquired via on-the-job training. So, if the time required to become fully proficient through on-the-job training significantly exceeds the amount of time the unit has before it deploys or engages an enemy, the unit's ability to satisfy its readiness criteria could be degraded.

It is difficult, if not impossible, to determine whether experience imbalances will degrade unit readiness without knowing what assumptions about skill-level mix were used in formulating unit manpower requirements. For example, manpower requirements for deployable maintenance units are based on the assumption that all maintainers are journeymen. However, in deference to the realities of a closed personnel system, the manning documents call for a mix of apprentices, journeymen, and supervisors. Actual configurations frequently consist of more apprentices and fewer journeymen than the manning documents call for. Apprentices are unable to do many tasks and typically take longer than a journeyman to perform those tasks they are capable of. These circumstances translate into a smaller maintenance capability than is assumed for force-structure design purposes.

Thus, to measure accurately the true impact of personnel resources on unit readiness, analysts must refine the personnel manning indicators (at least for maintenance occupations) so that the indicators distinguish between apprentice, journeyman, and supervisor manning. This is not as simple as it may seem. Currently, only the Air Force has a skill-level identifier system that is tied to job proficiency rather than to grade. The use of grades as a surrogate measure of skill level can produce misleading readiness indicators. This happens because promotion criteria are driven by personnel-management objectives, which change periodically. Resultingly, the time between promotions can change markedly from year to year, even though the time required to learn a job does not. Thus, for the Army, Navy, and Marine Corps, services that do not require job proficiency certification as a precursor to promotion, grade-mix data can be a poor indicator of personnel readiness. Additionally, a means must be devised for analytically relating the mix of personnel by skill level within an occupational specialty to a unit's ability to satisfy its readiness criteria.

The preceding presumes either that analysts can and do measure the proficiency of personnel in their wartime tasks, or that what analysts measure correlates positively to proficiency in wartime tasks. The combination of field-evaluation exercises and skill qualification tests does appear to do this reasonably well for combat and most support occupations. It should be noted, however, that there is no universally accepted, official definition of combat occupations. In the above context, combat occupations are those involved in acquiring targets and delivering ordnance on those targets.

Unfortunately, in many cases there is less than convincing evidence that proficiency at wartime tasks is being measured for maintenance occupations. This appears to be primarily a symptom of inadequate opportunity to perform many of the tasks that must be done during wartime, particularly emergency battle damage repair. Moreover, there is disturbing evidence that the push for peacetime effi-

ciency may be denying on-the-job training opportunities that are essential to obtaining proficiency at wartime tasks. During combat operations, for example, the Army expects its deployable nondivisional maintenance units to do troubleshooting and repair work on a wide range of components and subassemblies. However, this work is primarily being done by civilian-manned maintenance activities using production-line techniques at fixed sites. The military personnel in most deployable nondivisional maintenance units either are doing only remove-and-replace work or are troubleshooting and repairing only a limited spectrum of components and subassemblies. Additionally, most field-training exercises seldom run long enough to permit practice on the broad range of tasks expected of the maintainers.

The relatively long lead time required to turn a recruit into an apprentice maintainer (six months to two years, depending on the occupation) and the time required for apprentices to become proficient as journeymen (as much as one to two years for complex, high-technology equipment) necessitate that peacetime operating procedures and programs maximize the aggregate experience level of the available labor pool. All of the services recognize and strive to achieve this. Nonetheless, to accomplish this, the services need to pursue and implement means that ensure that maintainers get the on-the-job training that is requisite to proficiency at wartime tasks, even if it means detailing these people to the civilian-manned maintenance activities.

For Joint Chiefs of Staff readiness reporting, a unit typically is a brigade, ship or aircraft squadron.[2] Yet few, if any, of these units have the necessary number of equipment operators and the full complement of maintainers to keep the equipment operational. For example, the aircraft operated by the tactical fighter squadrons in an Air Force tactical fighter wing are maintained by the wing's aircraft-generation squadron, but the components used in these aircraft are maintained by a wing-component repair squadron. Another example would be the crew of a Navy surface combatant that is trained and equipped to provide at least emergency repairs to all equipment on board. However, Navy ships are designed such that sustained operational capability requires maintenance and repair support from a repair ship or from a shore intermediate maintenance activity.

This organizational separation of maintainers from operators is designed to yield benefits of economies of scale for high-cost resources and to offer flexibility for responding to battlefield developments. However, it makes it very difficult to gain an understanding of the relationship between maintenance resources and unit readiness.

The fact that a unit typically does not possess the

[2] *Army and Marine Corps internal readiness reporting procedures collect data by battalion or company.*

ILLUSTRATION BY JACK HALPERN

full spectrum of maintenance support necessary to achieve its readiness criteria suggests a need to devise a supra-unit basis for readiness measurement in our quest to analytically link resources to unit readiness. This should be easily achievable in the Air Force since a wing typically contains all of the units needed to maintain its assigned aircraft. In fact, the Air Force currently uses a unit-type code package measurement scheme for mobility units, thus capturing the total resources that deploy with the unit. However, an Army or Marine Corps division requires maintenance support from nondivisional units. Perhaps a *division slice* is a more appropriate entity for readiness reporting, but it must consist of units earmarked specifically to support the division in question or else the supra-unit readiness status would be notional and of no value to management in evaluating priorities for resource allocation.

In any event, for DoD to comply with Congress' mandate, the services must enlarge their readiness-reporting perspective to include extra-unit support contributions. Clearly, they must devise means of correlating the readiness indicators for extra-unit support resources with the capability of a unit to achieve its readiness criteria. In many cases the services also must install management procedures that transcend the existing command structure, such as where CONUS-based units will deploy to support Europe-based units, or where reserve-component units will be mobilized and deployed to support active-component units.

It is quite evident that DoD is under a mandate from Congress to devise some means of relating budgeted resources to readiness status. This will require the department to develop not only new and more meaningful readiness criteria, but also new, time-dependent readiness indicators. The principal challenge in the arena of personnel readiness is the formulation of indicators that will spotlight the criticality of shortages and the proficiency level of available personnel. The larger challenge is the integration of materiel and personnel considerations in readiness-status assessments. The services should also devise means for transcending organizational boundaries when doing so is requisite to capturing the true readiness status and effecting change.

Clearly, the job of quantifiably linking readiness to resources is no trivial task. Nonetheless, it is a job that must be done to ensure that the services get the resources they need to be ready to fight. DMJ

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Resource readiness in theory and practice

By ROBERT SHISHKO and ROBERT M. PAULSON

An analytical model that focuses on organizational output is providing new perspectives on unit readiness.

As Soviet armed forces have grown and modernized over the past ten years, U.S. military leaders have become increasingly concerned about sustaining this nation's qualitative superiority and improving the readiness of forces already in the field. Yet there are few analytical tools available to help readiness managers and DoD decision makers relate changes in the readiness status of forces to resource-flow decisions.

The Unit Status and Identity Report defines an operationally ready organization, ship, or weapon system as one "capable of performing the missions or functions for which it is organized or designed."[1] General David Jones, Chairman of the Joint Chiefs of Staff, recently elaborated further on this concept.

"*From my point of view, our state of readiness certainly determines how rapidly and with what effect peacetime-configured forces can be brought to bear upon various crises or conflict situations. It also includes how long and to what degree our forces can be employed. It embodies the capability to successfully accomplish tasks within a specified time with current resources and management systems.*"[2]

This and other recent definitions of readiness emphasize the capability of an operating unit to deliver a product or service over some period of time. Clearly, more is required than just a list of available resources and an appraisal of their current condition. At a minimum, the above definition suggests that a readiness measure must be output related and time conscious; that is, it must take into account the timeliness with which a unit can respond and the length of time and the circumstances under which the unit is expected to operate. Quite simply, readiness cannot be ascertained without asking what it is we must be ready for.

Although these ideas are not new, service regulations governing the reporting of readiness are not entirely responsive to them. For example, Army readiness reports offer a rather precise picture of a unit's resources and condition, but they say nothing about the unit's capability in output terms. Consequently, decision makers faced with allocating scarce resources do not have sufficient guidance from current reports to project the effect of varying resource levels on output. Clearly, a unit cannot be equally ready for all contingencies, regions, and weather, yet the readiness ratings do not make any distinction regarding these variables.

Each Table of Organization and Equipment unit is ostensibly designed to produce a product or perform a service over some time horizon. An ideal readiness measure should be sensitive to changes in the unit's ability to provide its product or service. It should also change whenever prevailing operating conditions or required operating durations change.

Defining the output of an Army maneuver or firepower unit is especially difficult because such units yield no single output or product that can be directly related to their mission. Maneuver units are designed to be used as a part of a combined-arms team. In this respect, the readiness assessment problem is similar to that of other multipurpose units like Navy carrier groups and Air Force multipurpose fighter wings, which have many outputs and missions. Nonetheless, the fact that combined-arms units perform a variety of battlefield assignments is not a handicap so long as the analyst is specific about which element of the output vector is being measured.

In peacetime, Army units train to do specific tasks which, in wartime, they must execute with great precision. When performed in a particular sequence, the tasks form an operation.[3] Thus, it is useful to think of a combined-arms unit's output in terms of a vector of its ability to perform conceptual operations of several specific types. The term specific operational capability (SOC) is used to represent each conceptual operation within this vector of output.

This concept of output embraces the unit's ability to marshal its equipment, crews, maintenance personnel, consumables, and other resources to carry out a specific operational capability. The unit's adequacy to defeat the enemy or hold territory is a consideration apart from this definition of output. Clearly, this measure of output is one-sided in that it does not project the outcome of a battle between two specified forces. Although prediction of a battle outcome is important in measuring capability, it is not

[1] *Joint Chiefs of Staff,* Joint Reporting Structure: Unit Status and Identity Report, *JCS Publication No. 6, April 1980.*

[2] *U.S. Congress,* DoD Appropriations for FY78: Statement of the Chief of Staff of the Air Force, *House Committee on Appropriations, 95th Congress, February 1977.*

[3] *In this discussion, an operation is deemed complete when the objective is seized or when a new position is established on active defense.*

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needed in measuring readiness. However, capability and readiness are closely related. In the simplest scheme, capability is a function of readiness—the attainable effectiveness of individual weapon systems in the field, number of units, unit training and cohesiveness, and the efficacy of doctrine.

A specific operational capability is determined by a usage profile and special conditions of employment. These determinants should depend on the employment scenario. For example, one would expect distances, terrain, weather, and other factors encountered during combat operations in the Middle East to differ appreciably from those in Europe. Consequently, assumptions concerning attrition, consumption and movement rates, maintenance task times, resupply schedules, unit rotation, and personnel-fatigue and personnel-efficiency factors should be specific to an operation plan where possible. In other words, because each unit is designed to generate a product that contributes to some operation plan, a readiness measure must be responsive to the employment and logistics concepts of that plan.

Each specific operational capability should also identify the operation-essential subsystems and training requirements. For example, if the specific operational capability calls for night operations by maneuver units, then such units should be equipped with the appropriate quantity and types of night-sight devices, and the crews should know how to use them. An *attack* specific operational capability for a combined-arms task force in Europe serves to illustrate the concept.

For each SOC and operation plan, it is possible to define a readiness index. Let $q^k_{ij}(t)$ be the rate of output for the i^{th} SOC under the j^{th} operation plan of the k^{th} unit in period t. Then, the cumulative output of the k^{th} unit for the i^{th} SOC and j^{th} operation plan produced between periods τ and $\tau + T$ is given by[4]

$$Q^k_{ij}(T, \tau) = \sum_{t=\tau}^{t=\tau+T} q^k_{ij}(t) \qquad (1)$$

The rate of output of the k^{th} unit is a function of the resources consumed by the unit. Let $x^k_1(t)$, $x^k_2(t)$, . . . , $x^k n(t)$ be that set of resources (manpower, equipment, spares, fuels, and munitions) consumed by the k^{th} unit. Then, the left side of Eq. (1) is more aptly written as

$$Q^k_{ij}(T, \tau) = Q^k_{ij}(x^k_1, x^k_2, \ldots, x^k_n; T, \tau) \qquad (2)$$

Another unit might have a different set of resources at its disposal and therefore might produce output at a different rate. Let $Q^o_{ij}(T, \tau)$ be the cumulative output of a reference unit, with everything constant except the resource set. We then can define a simple readiness index for the k^{th} unit as

$$R^k_{ij} = \frac{Q^k_{ij}(x^k_1, x^k_2, \ldots, x^k_n; T, \tau)}{Q^o_{ij}(x^o_1, x^o_2, \ldots, x^o_n; T, \tau)} \qquad (3)$$

In other words, a simple readiness index for the k^{th} unit is its output relative to a reference unit. It should be noted, however, that as a readiness index, Eq. (3) does not take into account two further considerations. First, for a particular SOC, the utility of output at time t might grow faster or slower than the output itself. Secondly, within a particular operation plan, output early in the battle might be worth more than output later since a commander might be willing to exchange two units of output on D + 15 for one unit on D + 1. It is possible to define a general readiness index for the k^{th} unit that accounts for these possibilities.

The idea of standardizing on the output of a reference unit is based on the belief that commanders will have a greater appreciation for the readiness of their unit when it is compared with a commonly accepted yardstick. To economists, this readiness index is just a normalized production function. The choice of the reference unit is arbitrary, but it makes sense to choose something Army commanders are attuned to. For example, one might choose a unit with its authorized complement of manpower and equipment, and unconstrained ammunition, fuels, and spares. Admittedly, no unit in the Army can ex-

[4] *In this discussion τ is always taken to be zero, but other starting dates are clearly possible.*

An attack SOC

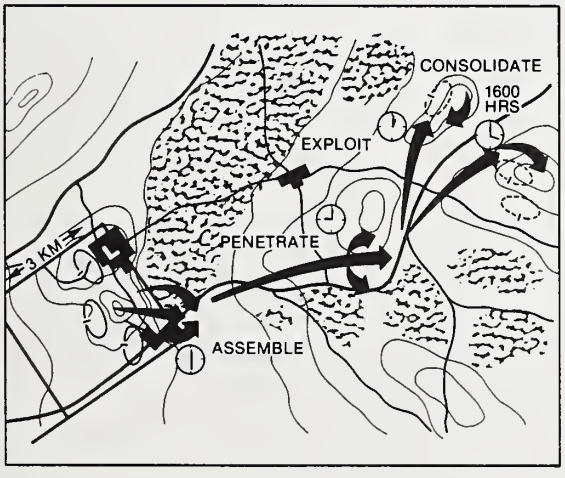
An attack SOC usage profile for a combined-arms task force is presented in the figure. The task force moves to an assembly area at 0600 hours, penetrates enemy lines, seizes an objective several kilometers away, and consolidates its position. The hour at which to complete each task as reflected in the schematic represents *expected value*. The consumption rates shown in the table represent the typical expenditure of ammunition and fuel by a tank and an armored personnel carrier. Cross-leveling, the practice of distributing remaining resources evenly among units at the end of the operation, would even out any variations.

In this usage profile, the fuel consumed during the operation and subsequent recycling is about 28 percent of the full fuel load of the M60A1 tank and about 30 percent of that of the M113A1 personnel carrier. (These fuel-consumption figures were obtained from the 1st Cavalry Division, Ft. Hood, Texas.) About 60 percent of the tank's 105mm ammunition load is fired during the operation.

The attack SOC can be further elaborated by specifying that the above usage profile take place on open terrain and in a chemical-biological-radiological environment. This specificity is advantageous in that it allows each SOC to be associated with training events and with specialized operation-essential equipment such as night-sight devices and air filtration kits. If training funds are highly constrained, not every unit can maintain proficiency in every aspect of armor combat. The SOC taxonomy facilitates a more precise identification and categorization of the particular operating conditions for which specific units are suitably trained and prepared.

A usage profile for an armored attack force

The consumption rates shown here represent typical expenditures of ammunition and fuel by tanks and armored personnel carriers conducting an attack. Such a taxonomy can be used to identify and categorize those operating conditions for which specific units are suitably prepared.



	Distance (km)	Engine Time (hrs.)	Fuel (gal.)	Rounds of ammunition 105mm	30 cal.	50 cal.
MOVEMENT TO ASSEMBLY AREA						
M60A1	10	2.0	13.0	0	0	0
M113A1			2.7	—	—	0
PENETRATION						
M60A1	4	1.0	9.0	24	500	200
M113A1			1.6	—	—	400
EXPLOIT TO OBJECTIVE						
M60A1	40	4.0	52.0	16	500	100
M113A1			10.8	—	—	300
CONSOLIDATE						
M60A1	1	1.0	1.3	0	500	0
M113A1			.27	—	—	300
CROSS-LEVEL						
M60A1	0	2.0	10.0	0	0	0
M113A1			3.0	—	—	0
RECYCLE						
M60A1	—	4.0	20.0	0	0	0
M113A1			6.0	—	—	0
TOTAL						
M60A1	55	14.0	105.3	40	1,500	300
M113A1			24.4	—	—	1,000

pect these conditions in wartime; nonetheless, this set of resources should allow the unit to reach its maximum potential output. In theory, the denominator of Eq. (3) could be any number, but regardless of what number is chosen for the denominator, the percentage change in the readiness index is equal to the percentage change in output under that specific operational capability.

The readiness index defined by Eq. (3) has a number of advantages over the REDCON ratings. First of all, it is a continuous function rather than a four-cell classification scheme. Secondly, the index is responsive to all resources that affect output. And finally, the proposed index recognizes the substitutability of resources. Thus, two units with different resource sets but which produce the same output would be rated equal; however, under current readiness reports such as those prepared under AR 220–1, the units might not be. Clearly, the proposed index permits managers to allocate resources to achieve varying levels of readiness. Because current reports do not recognize input substitutability, the resource manager attempting to maintain a certain level of readiness has little discretion to alter the mix of inputs when relative scarcities change.

The above concepts of readiness were applied to a combined-arms brigade consisting of two armored battalions and one mechanized infantry battalion embedded within division and corps structures. For analytic purposes, these units were divided into three identical combined-arms task forces consisting of two armor-heavy company teams and one mechanized infantry-heavy company team.

A model called AURA (Armored Unit Readiness Assessor) was used to determine the relationship of inputs to outputs for each specific operational capability. AURA is a powerful event-simulation model that permits decision makers to examine the prospective impact of alternative resource levels on a combat unit's output levels and to assess a broad range of policy options that could affect resource-allocation decisions on a theater-wide basis. It also allows examination of the effects of attrition, replenishment, and higher-echelon repair on continued operations. It should be noted that the readiness concept discussed here does not depend on the use of any particular model; in principle, one could use any analytic tool that translates a flow of inputs into a flow of SOC-related output.

In each simulation, AURA organized and monitored the manpower and other resources of the brigade and its supporting Forward Area Support Team and Division Support Command. Maintenance task times and frequencies for the brigade's two pacing items, the M60A1 and M113A1, were taken from the Contingency Maintenance Allocation Charts published in FM 42-9-1 and FM 42-9-9. The brigade's pacing items were assumed to be fully mission capable at the start of the 15-day simulation. Overall attrition was parametrically varied and probabilities were assigned to various attrition events.

It should be kept in mind that although AURA does not model the enemy explicitly, it does model the effect of enemy actions that cause the brigade to lose resources and time.

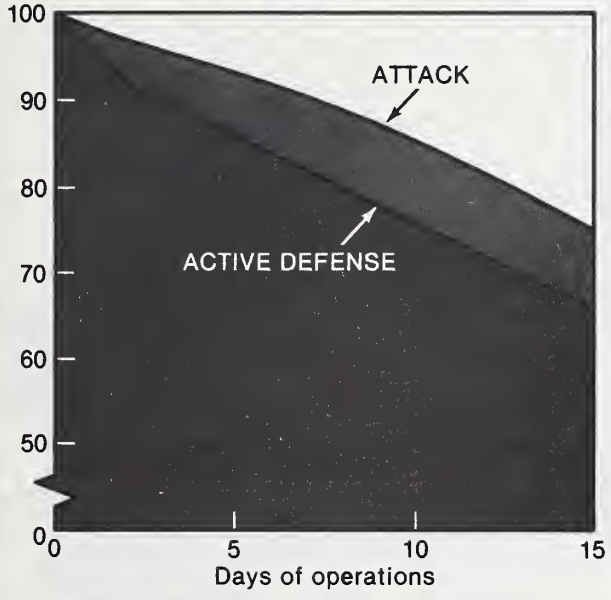
The combined-arms brigade was simulated under the attack SOC (shown in the figure of the sidebar article on p. 17) as well as an active-defense SOC. Both SOCs were representative of what a combined-arms brigade might have to do in a major conventional conflict. The simulation produced an estimate of the brigade's output, specifically the number of ready platoons obtainable with different quantities of manpower and consumables, that could be amassed at the appropriate time for each operation.

As could be expected, a brigade with more or better manpower, consumables, and replacement end items produced more output than a brigade with fewer resources for both SOCs investigated. Surprisingly, though, a combined-arms brigade with strictly limited resources was found to be not equally ready for both SOCs. The readiness index computed by using Eq. (3) for either SOC depended on the assumed attrition rate and time horizon over which the brigade must sustain the SOC.

The figure presents some representative results for the armor components of the brigade. This brigade

Differing readiness levels of a simulated combined-arms brigade

Compared to a reference combined-arms brigade with unlimited resources, a resource-constrained brigade was found to be not equally ready for both attack and active-defense SOCs.



had its full complement of manpower and equipment and had unconstrained stocks of POL and ammunition.[5] However, it had only representative, and hence limited, stocks of pacing-item spare parts at the organizational and intermediate levels. The readiness index shown on the vertical axis was computed as the output of that brigade relative to an identical brigade that performed the identical SOC and suffered the same attrition, but which had unconstrained access to spares. This identical brigade is referred to as the *reference* unit.

The figure on page 19 shows that at 20-percent attrition per day, the brigade produces 75 percent of the armor output of the reference brigade over 15 days, but as much as 97 percent of the armor output over the first two days when performing the attack SOC. Similarly, at 20-percent attrition per day, the brigade being measured produces 66 percent of the armor output of the reference brigade over 15 days and 92 percent of the armor output over the first two days when performing the active defense SOC. For other specific operational capabilities, the curves might be different. As a general rule, a combined-arms brigade's resource readiness index will be higher for those SOCs that demand *relatively* less of the brigade's scarcest resources.

When resources are increased, the readiness curves for each SOC shift upward; however, each resource affects the curves differently. The ability to measure the effect of variant resources on different types of output permits a resource manager to tailor readiness improvements according to the desired level of readiness for each type of output and to the relative marginal cost of each such improvement. Such a capability is clearly a valuable tool for determining resource requirements.

In addition to these resource-requirements issues, there are some near-term management concerns that might be addressed using the readiness concept presented here. These concerns include the allocation and distribution of existing resources, the selection of units to perform specific operations during periods of crisis, and the evaluation of system and managerial effectiveness. Envisioned as a supplement to readiness reports is a system that rates each unit according to its ability to perform various specific operational capabilities under various operation plans. The actual value of the resulting information depends on the ability of decision makers to rapidly allocate resources across units in response to readiness deficiencies. And while different uses of readiness measures may require different kinds of readiness information, it is apparent that all uses require some understanding of the relationship of inputs to outputs. DMJ

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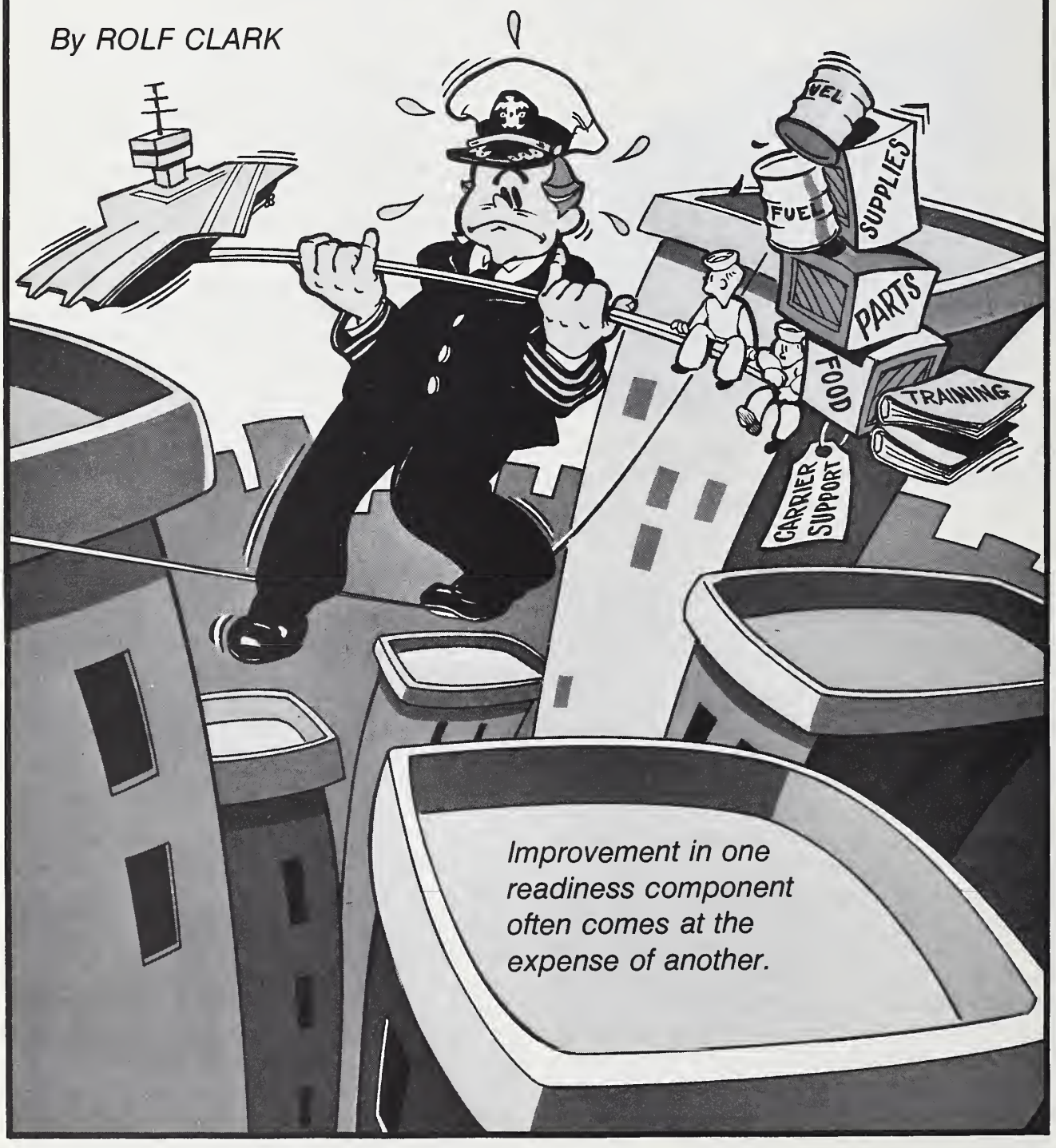
[5] *These stocks were unconstrained within parameters of the prescribed consumption rates for each specific operational capability.*

Readiness as a residual of resource-allocation decisions

By ROLF CLARK



When a naval task group goes to sea, its capability to meet a threat depends largely on its readiness. The task group commander will be very much concerned about different types of readiness: material, personnel, operational, and mission readiness. Nonetheless, the task group's effectiveness will depend on factors imposed by Department of Defense and Department of the Navy policy makers who over the last several years have allocated financial resources in ways that largely determine the task group commander's ability to make his force ready.

Policy makers clearly control such factors as supply levels, replenishment spares, manpower levels, operating time, and maintenance backlogs, making it imperative that they employ tools and techniques that help them allocate resources efficiently. These various factors, which can be viewed as readiness indicators, are central to an understanding of the proposed approach to analyzing the readiness-to-resources trade-off, for it appears that policy makers can accurately monitor progress in fleet readiness by watching the trends in appropriate readiness indicators.

It can be argued that such trade-offs can be made intelligently only if the entire resource-allocation process and its expected long-term effects are carefully considered. This calls for a policy model that sacrifices detail for comprehensiveness, a tack that facilitates rapid *what-if* analyses of policy alternatives.

Under a fiscally constrained budget, policy makers must realize that improvement of one readiness indicator will mean that readiness in another area may be sacrificed. Improving support factors such as supplies, spares, underway time, or manpower levels may mean a relative reduction in funding for procurement. In such a case, current readiness may improve at the expense of future force levels. Similarly, under fiscal constraints, the reduction of maintenance backlogs to enhance material readiness may require a reduction in training time, which generally results in a sacrifice of personnel readiness.

The appropriate framework for this kind of policy analysis is based on the traditional trade-off between the acquisition of new forces and the support of existing forces through increased ownership funding. Acquisition enhances readiness in a quantity sense, since more units are added to the fleet. This quantity facet of readiness is often referred to as capability. Ownership expenditures improve readiness in a quality sense since each unit becomes better maintained, more adequately manned, and more efficiently operated.

Certainly, the many trade-offs that must be made are too complex for the human mind to track simultaneously, making the use of a dynamic model essential. Proposed here is a simulation modeling approach that combines the systems approach to complex dynamic management situations with the capabilities of digital computers. For complex problems like the allocation of resources over the next 20 years, intuitive judgment about how the system will change with time is unreliable, even if based on a good knowledge of the components that make up the system. As one observer stated:

The systems approach to problems focuses on systems taken as a whole, not on their parts taken separately. Such an approach is concerned with total-system performance even when a change in only one or a few of its parts is contemplated because there are some properties of systems that can only be treated adequately from a holistic point of view. These properties derive from the relationships between parts of systems: how the parts interact and fit together.[1]

The systems approach will prevent policy makers from overemphasizing one aspect of readiness while inadvertently sacrificing overall readiness.

A policy maker must integrate a number of trade-offs into the decision-making process. For example, increased funding to shipyards to reduce overhaul backlogs may mean decreasing depot maintenance for aircraft; increased procurement budgets to obtain more forces may mean increasing funding to support those forces, which in turn means fewer future procurements because of budget constraints. Perhaps less obviously, increased force levels through the acquisition of less expensive, smaller units may lead to economic inefficiencies since small units cost more per ton to operate and maintain, causing total fleet ownership costs to rise and future procurement dollars to decline. In the manpower area, increased operating time may improve personnel readiness; however, if increased operating time curtails reenlistments, overall per-

[1] *Russell L. Ackoff, "Towards a System of Systems Concepts,"* Systems Analysis Techniques *(New York: John Wiley and Sons, 1974), p. 27.*

ILLUSTRATION BY RALPH BUTLER

sonnel readiness declines through loss of experience.

These individual trade-offs should not be treated in isolation from the total Navy allocation policy. Although many of these trade-offs are already monitored by the Navy, they are not incorporated into a centralized, policy-level, analytical framework. Such a framework is needed for sustained optimization of force levels, force support, and overall readiness.

What becomes obvious from this discussion is that these relationships are interactive. In a simplistic sense, there is a circular trade-off. Figure 1 reflects the basic feedback mechanism at work in the context of the trade-off between assets and support. If the Navy chooses to increase the readiness quality of units by allocating more funding to ownership, then less of the budget remains for acquisition. Acquisition funds secure new assets to complement existing assets. The quantity and type of current assets determine the ownership funding that will be required for the following year, and the cycle repeats in ensuing years. Of course, this basic model represents just the core. It must be expanded to include many functional relationships.

Figure 2 is an expanded version of Figure 1. Acquisition is segregated into procurement and research and development. Research and development affects manning, operating, and maintenance characteristics such as failure rates, crew size, and fuel efficiency. These characteristics obviously affect the required ownership funding, which is now shown to depend on policies and on the quantity and characteristics of assets. Policies calling for more operations, better maintenance, and higher manning create a need for more ownership funding.

In this context, the quantity aspects of readiness are embodied in current asset levels, which might be measured in terms of units, tonnage, cost, or value. Changes in these quantity measures indicate increases or decreases in fleet readiness from a capability standpoint. The quality aspects of readiness are inherent in the gap shown between ownership funds required and those supplied. In its quality sense, readiness will decay as the annual resource gaps accumulate.

Because these funding shortfalls are measurable, they provide a means of quantifying the loss in readiness quality. For example, if the funding required is specified to be that amount which maintains asset quality at last year's level—the same operational time, supplies, manpower, and maintenance per unit—then the size of the shortfall reflects the readiness decay. The shortfall can easily be disaggregated into the maintenance, operations, and manpower areas. As the ownership funding shortfalls accumulate and readiness decays, pressure is applied toward increasing the Navy budget. But policies are also affected—operating tempos may need to be decreased and maintenance reduced. Such moves improve readiness one way by making more funds available for one readiness area, but they clearly lead to decreased readiness in other areas. For example, increased funding for procurement would likely result in reduced operational training and greater maintenance backlogs. A computer simulation of this model tracks all the variables and interactions, thus helping policy makers consider the readiness impacts of alternative allocations, something they could not do intuitively.

A model's functions and constants must be known. They must be derived from historical fleet data, which also provide a perspective on fleet evolutionary trends that must be acknowledged in projections. Since 1962, the number of ships has

Figure 1. The dynamics of the Navy resource allocation process

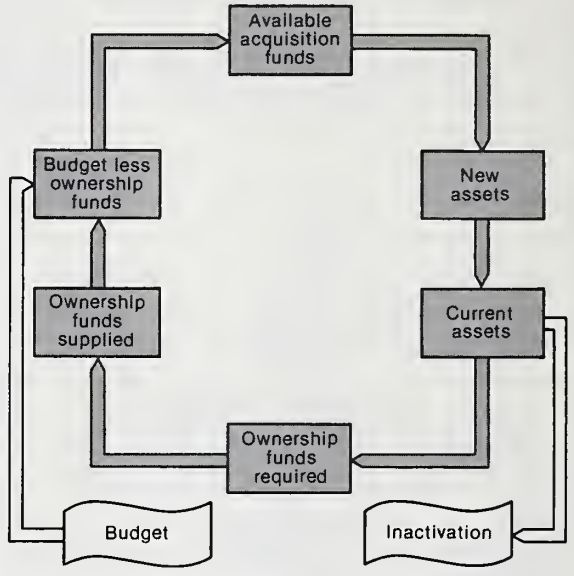
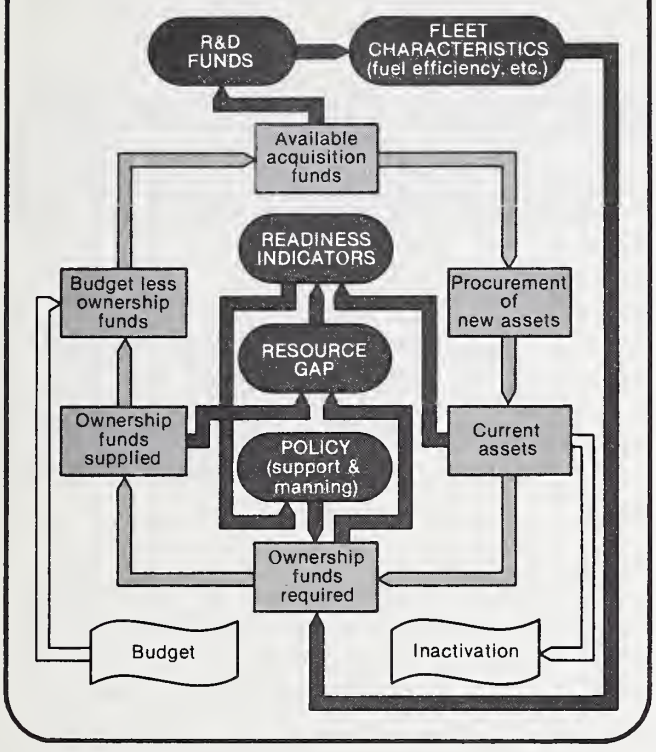


Figure 2. An expanded view of resource dynamics



decreased by about 50 percent and fleet tonnage has decreased by about 20 percent. Nonetheless, the total constant-dollar depreciated-asset value of ships in the inventory actually rose more than 10 percent. It seems that a combination of things occurred. The fleet was purged of small tonnage ships, which were replaced by fewer but larger ships. More was paid per ton for the new ships as equipment became more sophisticated. The increasing asset value indicates a Navy of greater capability than the earlier fleet. Thus readiness, when measured in quantity terms, increased relative to the earlier fleet.

However, if today's fleet is compared with the 1962 fleet in terms of ownership expenditures, a relative decrease is observed. For while assets rose in value, the flow of resources directly toward operating, maintaining, modernizing, and supporting the fleet declined about 7 percent in constant dollars and about 17 percent relative to asset values. Funding expended on ship repairs, overhauls, and conversions declined 16 percent. By 1977, each dollar of assets was maintained with about 25-percent less funding than in the early 1960s. In the past few years, however, there has been a reversal in this downward trend in support funding. It is important to realize that by viewing the naval trends in a macro sense, one can gain a better perspective on the long-term effects of policy.

Some readiness indicators tend to confirm that the reduced ownership funding caused a decline in readiness quality, at least in the policy-level sense. The value of items in the supply system was down 35 percent; units overdue for overhaul rose from insignificant levels in 1962 to 10 percent of the fleet in 1977; steaming hours per person decreased 16 percent; manning levels decreased 35 percent; and on-board ship spares declined 35 percent relative to assets.

In aircraft, similar trends are apparent. Aircraft assets in terms of number of units declined 43 percent; in terms of mass, they declined about 20 percent. However, the depreciated constant-dollar asset value rose about 25 percent. Meanwhile, allocations for support declined relative to asset values; replenishment spares declined by 50 percent; aircraft rework by 6 percent; support equipment by 37 percent; and modifications by 18 percent. Again, the measurable readiness indicators were consistent with the reduced funding ratios.

Since 1977, aircraft support funding has increased about 7 percent. As a result, aircraft on extension represent about 14 percent of the inventory as opposed to 17 percent in 1977. In the last three years, ship maintenance funding has increased 16 percent more than assets and there are now about 20 ships overdue for overhaul compared with almost 50 in 1977.

Given the functional relationships, the policy maker can exercise the model, conducting *what-if* drills by varying the available budget controls and comparing the outputs over the 20- to 30-year planning horizon. Some sample explorations using a preliminary model are demonstrative. In 1977, the backlog of ships overdue for overhaul represented about $1.3 billion in 1979 dollars. This backlog could have been reduced and material readiness improved by increasing overhaul funding. However, one must question how this might have reduced readiness somewhere else.

A simulation of the ship sector indicates that reducing the backlog to zero in three years would re-

duce the number of active units in the fleet over the next 18 years in the following manner: no significant change the first 5 years; one less ship in year 6; two less per year in years 7 and 8; three less in year 9; two less per year in years 10 through 14; one less per year in years 15 through 20. This represents a total of 24 shipyears lost over that period. If instead the backlog were reduced over a 10-year period, the active fleet reduction would be about 20 shipyears over the same period. Consequently, a decision maker could conclude that reducing the overhaul backlog quickly is more detrimental than smoothing it out over time.

Similarly, one might wish to determine the relative impact on force levels of different inflation rates for fuel costs. The maintaining of operating time at historical levels to avoid losses in operational training will cause losses in force levels if fuel costs rise faster than the inflation norm. Using the preliminary simulation, one finds that if fuel costs annually rise 5-percent faster than the overall DoD inflation rate, a total of about 55 shipyears would be lost over a 25-year period. This is because operating costs will require about 75 percent more funding over the 25-year period if steaming hours per unit remain at recent annual levels to avoid decreased operating readiness. For such a calculation, the overall Navy budget was assumed to grow at a real 3-percent rate and the increased fuel costs meant decreased procurements.

There can be little doubt that explorations like the ones addressed here can be instrumental in helping decision makers plan efficiently and respond rapidly to inquiries from a public concerned about defense spending. By understanding the many feedback interactions in the pursuit of improved readiness, analysts and policy makers charged with the allocation of resources can gain a better understanding of the inherent complexities of the quest. DMJ

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By ZEEV BARZILY,
LT. COL. PAUL R. CATALOGNE, USMC,
and W. H. MARLOW

Assessing Marine Corps readiness

A highly structured readiness evaluation system is pointing out deficiencies and shaping remedial training.

The difficulty of measuring the readiness of a military unit is largely attributable to the fact that such a measurement cannot be made under actual combat conditions. Instead, it is obtained through exercises consisting of typical operations the unit is supposed to be able to execute. Moreover, it is generally necessary to evaluate performance in terms of the unit's conformance to doctrine rather than the unit's ability to do its job. This is true because it is generally simpler to determine the success of an operation and to identify the strong and weak points of execution than it is to determine why a unit performed as it did and what the performance foretells.

The Marine Corps Combat Readiness Evaluation System (MCCRES) employs simulated combat to evaluate the readiness of Marine units. Tests have been designed to evaluate infantry units, rotary-wing and observation squadrons, fixed-wing squadrons, combat-support elements, combat service-support elements, and so on. This discussion, however, will be confined to infantry units and will address two questions:

- How can results from MCCRES performance evaluations be used to determine how well the unit can do its job?
- How can units best train in anticipation of their formal evaluations and in response to evaluation results?

The approach is based on a categorization of ten fundamental activities that an infantry battalion must be able to do if it is to be considered ready for combat.

MCCRES data, especially when they are supplemented by the new evaluation measures, are ideally suited for helping commanders evaluate readiness and design training programs. These new evaluation measures help to explain why units performed the way they did and point toward the necessary remedial training actions.

Ultimately, combat readiness is achieved through a combination of training management and asset allocation. Because these functions cannot be neatly separated, a system that involves both, as does MCCRES, is particularly useful. MCCRES can be employed at the unit level or at the force-planning

Figure 1. MCCRES mission performance standards for infantry units

STANDARDS APPLICABLE TO ALL EVALUATIONS
- Continuing actions by Marines
- Command and control
- Fire-support coordination

STANDARDS APPLICABLE TO AMPHIBIOUS ASSAULT AND NORMAL COMBAT OPERATIONS ASHORE
- Surface assault
- Helicopter-borne assault
- Movement to contact
- Attack
- Night attack
- Defense
- Retrograde operations

STANDARDS APPLICABLE TO SPECIALIZED COMBAT OPERATIONS
- Tank-infantry operations
- Mechanized operations
- Military operations in built-up areas
- Evacuation operations
- Amphibious assault

STANDARDS APPLICABLE TO OPERATIONAL ACTIONS DEPENDENT UPON OUTSIDE ASSETS
- Amphibious assault planning
- Embarkation for amphibious assault
- Sea transit and rehearsal for amphibious assault
- Air assault using fixed-wing transport aircraft

level, so answers to the two posed questions are of consequence to all levels of the Marine Corps.

In designing formal evaluations of infantry units, evaluators choose applicable mission performance standards from those presented in Figure 1 (p. 25). As shown in Figure 1, there are four sections that encompass everything a Marine infantry battalion could be expected to be able to do. The three standards in the first section represent the most fundamental capabilities and must be tested in every MCCRES evaluation. Testing of most of the standards in the second section is also compulsory; however, evaluation of those in the third and fourth sections is optional. As a practical matter, it would be impossible to test all of the mission performance standards in a single evaluation. The standards and other elements of MCCRES that are tested in an evaluation are called *applicable* and the ones omitted are said to be *nonapplicable*. The choice to omit or include is made by the evaluating command.

Figure 3. Requirements for use of camouflage and concealment

- Individual Marines demonstrate attention to detail (KI).
- Vehicles are prepared for concealment with garnished netting and natural camouflage (KI).
- Equipment and tentage are provided with appropriate netting or are concealed with natural material.
- Individual firing positions and those chosen for crew-served weapons are camouflaged to prevent detection by the enemy (KI).
- Organization stresses placement of men and material in areas that are concealed from casual detection by enemy aircraft.

Figure 2. Tasks for three mission performance standards

CONTINUING ACTIONS BY MARINES
- Discipline
- Dispersion
- Use of cover
- Use of camouflage and concealment
- Security actions
- Reconnaissance patrolling
- Combat patrolling
- Response to enemy electronic warfare capabilities
- Response to enemy chemical warfare capabilities
- Response to enemy air capabilities
- Handling of prisoners of war
- Casualty handling

SURFACE ASSAULT
- Debarkation
- Assault across the beach
- Seizure of objectives
- Buildup of combat power ashore

ATTACK
- Planning
- Preparation
- Preliminary operations
- Maneuver forward of line of departure and short of final coordination line
- Assault from final coordination line through the objective
- Consolidation
- Employment of the reserve
- Response to counterattack
- Command post displacement

Each standard consists of a number of specific tasks (see Figure 2), and each task consists of a number of requirements. Figure 3 presents the five requirements composing the task identified as *use of camouflage and concealment*. The *KI* entry denotes the existence of *key indicators*, meaning that the requirement contains detailed criteria. For example, in order to satisfy the fourth requirement in Figure 3, it is necessary that *no more than 25 percent of the positions can be detected from an enemy vantage point 50 meters forward of the ground occupied by the unit.*[1] All applicable requirements pose questions that can be answered with a *yes* or *no*. A unit earns a yes only if all conditions of the requirement are satisfied.

After the applicable mission performance standards have been determined, the second phase of a MCCRES evaluation begins. This phase consists of briefing the evaluators, who usually are officers and senior enlisted men whose battalions will be evaluated in the near future. At the briefing, the evaluators are assigned to the components of the unit to be tested, informed of the applicable parts, and instructed on how to observe details of performance and how to decide between *yes* and *no* for individual requirements.

The third phase is the simulated combat. During this phase the evaluators must pay careful attention to many aspects of the execution and make many

[1] *Marine Corps Combat Readiness Evaluation System, Volume II, p. 2-11, 1978.*

quick judgments. Guided by the key indicators, they confer a *yes* or *no* on all applicable MCCRES requirements.

When the simulated combat is finished, the evaluators, under the supervision of the senior evaluator, issue a final *yes* or *no* for each requirement. The end result is a *yes* or *no* for the entire battalion.

The next phase consists of computing numerical scores. Weights of relative importance have been assigned to each applicable element in MCCRES. Weights for nonapplicable items are distributed among the applicable ones. There are relative weights for each standard, each task, and each requirement. Consequently each applicable requirement has its own share of 100 percent, namely the appropriate share that comes down by inheritance from section to standard to task to requirement.

Requirements receiving a *no* evaluation score 0 percent and those receiving a *yes* score the maximum. Tasks are then evaluated by summing the scores. Thus, each applicable mission performance standard receives an evaluation of up to 100 percent through accumulation of scores from its component elements. So a score of 92 percent for the battalion would mean that 92 percent of the applicable requirement weights were evaluated *yes*.

The ultimate result of the MCCRES evaluation is the senior evaluator's judgment of *combat ready* or *not combat ready*. Once this judgment is made, several reports are filed that include lists of comments on requirements evaluated. These reports furnish considerable information on the weaknesses and strengths of the battalion. Also made is a list of the evaluations for each requirement and a single final percentage score for the entire battalion. These percentages reflect how the exercises were performed and offer a good insight into how well the unit can do its job.

Figure 4. Ten categories of MCCRES requirements for infantry units

- REPORTING to higher levels of command
- PREPARING for operations
- COMMUNICATING (including Communications SOPs)
- PERFORMING as Marines (discipline, dispersion, camouflage, concealment, using weapons, and so on)
- DELIVERING supporting fire
- PLANNING operations
- CONFORMING to doctrine
- EXECUTING operations
- PROVIDING combat service support (including medical support)
- SUPERVISING required actions of individual Marines

Figure 5. Requirements for the task of preparation for attack, plus associated classification categories (in parentheses)

- Unit organizes for combat (EXECUTING)
- Subordinate leaders prepare and issue operation orders (PREPARING)
- Individual Marines and their equipment inspected and weapons checked (PREPARING)
- Ammunition stocks distributed and additional ammunition for indirect fire weapons positioned (PROVIDING)
- Security increased to protect unit as it concentrates on assembly areas (CONFORMING)
- Vehicles checked for fuel levels and refueled (SUPERVISING)
- Distribution of communications security material checked (COMMUNICATING)
- Supplies and equipment prepared for movement to the objective after seizure (PROVIDING)

Because evaluators must be constantly attentive to the details of the unit's performance and because determinations of *yes* and *no* are very tedious, the requirements are grouped so that the scoring is simplified as much as possible. Thus, instead of assessing the performance of the unit's command, staff elements, technical members, and its individual Marines, the evaluators assess the unit's success in performing the different mission performance standards. Keep in mind that it is much simpler to decide how successful an operation was and to identify the strong and the weak points of execution than it is to determine why a unit performed as it did.

The approach proposed here calls for all 800 MCCRES requirements to be classified according to the categories listed in Figure 4. Requirements for the task of *preparation,* along with the associated classification categories, are presented as an example in Figure 5. Note how the different categories cut across boundaries. For example, even though the task itself is preparation, only two of its require-

ments are categorized as *preparing*.

An explanation of the meaning of the categories is in order. Six of the categories together, namely *planning, preparing, executing, reporting, conforming,* and *supervising,* mainly evaluate the performance of the command. *Performing* evaluates the performance of individual Marines. The third collection, consisting of *communicating, delivering supporting fire,* and *providing combat service support,* evaluates the performance of some special groups.

The *planning* category addresses the question of how well the operations are planned. *Preparing* applies to activities that start after some phases of planning have been completed. Preparations include the issuance of orders, rehearsing, and the completion of other preliminaries. The *executing* category is applicable to requirements that measure teamwork and command leadership. *Reporting* includes acknowledgements of receiving orders, reports on the progress of operations, and reports on the enemy. The next category which evaluates mainly the command is *conforming*. Included in that category are command-related requirements that are easily satisfied so long as the command does not overlook them. *Supervising* pertains to requirements that are satisfied through observation and appropriate direction, usually at or below the company-commander level.

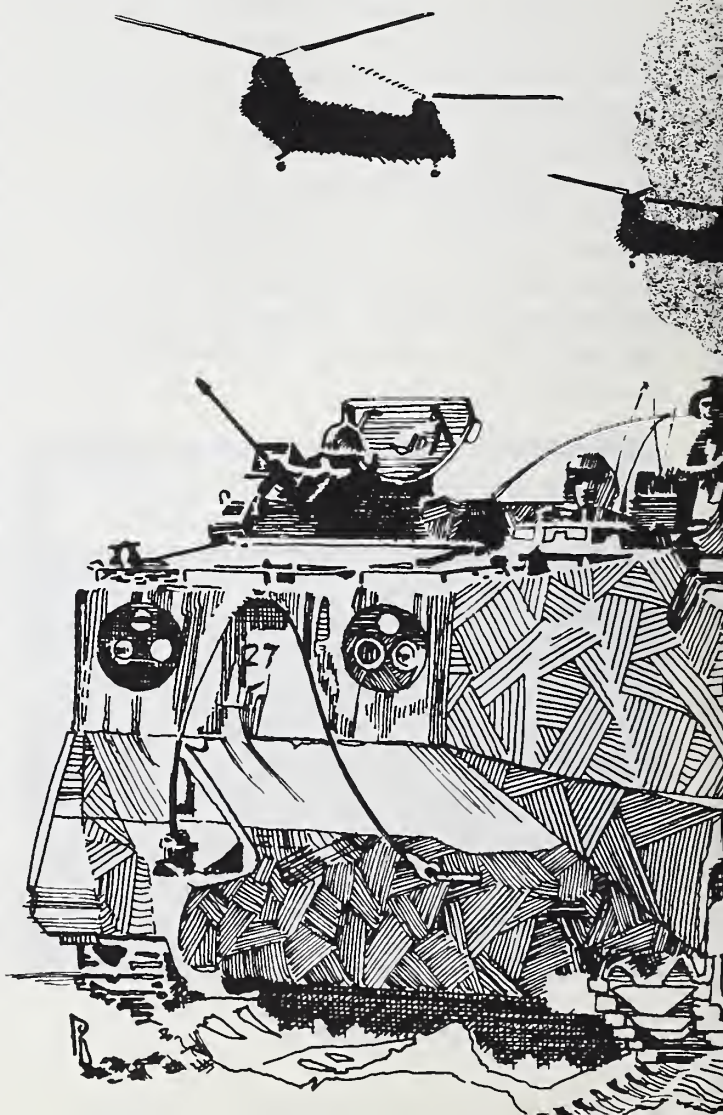
The three remaining categories are for the evaluation of special groups. *Communicating* pertains to the performance of the teams responsible for radio and wire communications. The question asked here is whether the units transmit the required information in the proper manner. *Delivering* applies to the performance of the supporting fire units and *providing* to the performance of logistics and medical groups.

Each of the ten categories corresponds to a vital aspect of the unit's performance during the evaluation, and each requirement is assigned to the single category that is most appropriate for the primary feature of the requirement. These ten categories make it possible to classify all the requirements and to do so in a way that they correspond to special areas for training and remedial actions for improving combat readiness. The categories can be viewed as the distinguished set of activities that constitute the capability of Marine infantry units to do their jobs.

Under MCCRES, a score for each of the ten categories—that is, the percentage of applicable requirements weights that were evaluated *yes*—can be calculated and used. These ten scores reflect fundamental outputs for the units tested. These category scores may be the single most useful MCCRES measure in determining if the unit can do its job.

Commanders know the MCCRES standards and are consequently able to effectively prepare for their formal evaluations. Additionally, units are able to train in response to evaluation results because requirements belonging to the same category pose similar demands on the unit.

It is advocated that category scores be used for isolating trends and for focusing training on those fundamental aspects of performance that cut across numerous mission performance standards and tasks in MCCRES. This can be illustrated by contrasting two sets of scores. Figure 6 displays two sets of ten category scores from an MCCRES evaluation. Although the two sets of scores differ substantially,



both could have been derived from the same set of official evaluation scores.

The training program that would be recommended based on the first set of scores in Figure 6 would concentrate on mission performance standards, *continuing actions by Marines*, and would place command emphasis on logistical planning and support. This is because the score for *performing* is the lowest and is considerably lower than the score for *executing*. This is usually a direct indication that leaders of small units are unable to carry out orders quickly and effectively.

The scores in the second set indicate the need for better preparation for exercises. Command-post exercises involving sub-unit leaders and battalion staff officers would be particularly appropriate. The score is high in *planning* and notably low in *preparing*. A high score in *planning* accompanied by a low score in *preparation* reflects a degradation in the unit's ability to execute. The low scores in *performance* and *supervising* indicate a need for command-post exercises and limited field exercises.

In essence, category scores offer a basis on which to effectively orient remedial training. It should be noted that this can be done at all levels, thus allowing commanders to direct training efforts at identified weaknesses.

There are other uses of the categorization scheme.

Figure 6. Two sets of MCCRES category scores suggest differing needs for remedial training

	Set 1	Set 2
• Reporting	91%	94%
• Preparing	95%	**84%**
• Communicating	90%	94%
• Performing	**74%**	**71%**
• Delivering	94%	99%
• Planning	91%	**96%**
• Conforming	77%	94%
• Executing	**98%**	90%
• Providing	76%	94%
• Supervising	81%	**74%**

For example, it can help identify which standards should be applicable in forthcoming MCCRES evaluations. It can also suggest substitute standards to use in place of some requiring special assets or considerations—for example, helicopter-borne assault or night attack.

Strongly evident in the Marine Corps Combat Readiness Evaluation System is the value of the categorization scheme in providing insights into the true ability of a unit to do its wartime job. Additionally, this evaluation system has vast potential for quantifying that critical relationship between resources and readiness. DMJ

ILLUSTRATION BY RALPH BUTLER

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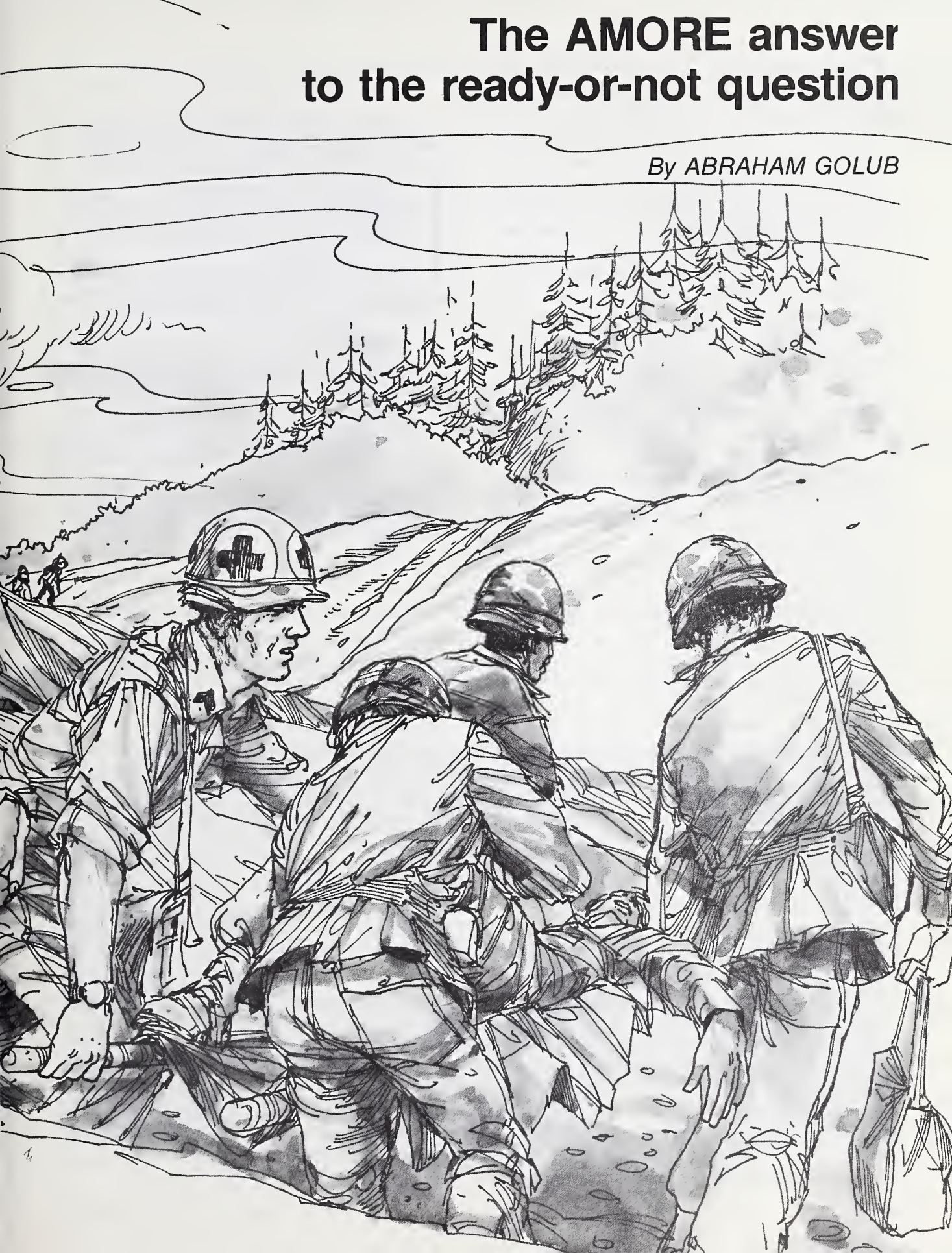
ILLUSTRATION BY BOB GEORGE

A proposed readiness rating system helps fill in the gaps between current statistical ratings and subjective analyses.

The AMORE answer to the ready-or-not question

By ABRAHAM GOLUB



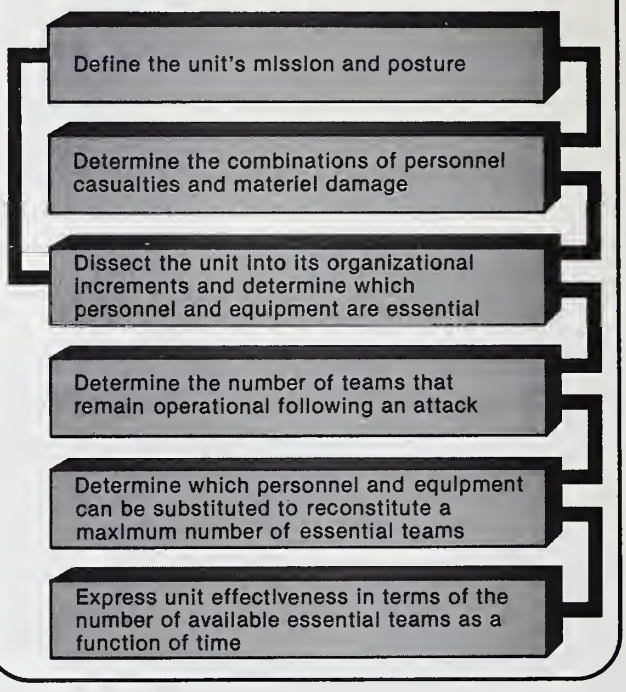
Detailed examination of methods currently used for assessing unit combat effectiveness and general unit readiness has given rise to considerable concern about those methods' effectiveness at determining the true readiness of our armed forces for sustained combat. One outgrowth of this emerging concern is a newly developed methodological approach called Analysis of Military Organization Effectiveness (AMORE).

Historically, the measures of unit combat effectiveness that have been used in combat models, simulations, and war games have been based almost exclusively on attrition counts. These measures do a good job of pointing up the number of personnel casualties or damaged items in a unit that has been degraded by some mechanism such as conventional and nuclear munitions or peacetime readiness shortfalls. The counts are then used as a surrogate for assessing the resultant effectiveness of the unit. For instance, some level of personnel casualties, say 30 percent, could be judged adequate to spell defeat for the unit or to result in some lesser level of unit capability. In some instances, a level of materiel damage is employed as the surrogate. In others, both personnel and materiel attrition levels are recorded and the reader is left with the task of determining what it all means.

Only rarely have materiel and personnel counts been considered together, and never have they been combined in a manner that resulted in a credible measure of the unit's overall effectiveness. More importantly, the mere use of attrition counts does not take into account the fact that a unit's effectiveness is not fixed in time. For example, a unit's ability to reorganize and reconstitute its remaining resources must be considered. The fact that time is as important a resource as personnel and materiel has never been addressed adequately.

Paradoxically, our unit readiness rating systems have always stressed the need to consider personnel skills, materiel, and unit training simultaneously. Unfortunately, the related statistical measures and the way in which they are employed fall short of either fulfilling that need or attaining the stated objectives. These measures provide neither an accurate assessment of a unit's readiness to accomplish its combat mission, nor an effective means for managing the necessary provision and allocation of resources. The inefficiency of current systems to assess a unit's readiness for combat is a result of the aforementioned deficiencies in assessing unit combat effectiveness. The inability of current systems to manage the allocation of resources is a result of a failure to weight the values of the individual skills and items of equipment the unit comprises.

Figure 1. The AMORE approach



In all fairness, though, the services have duly acknowledged the shortcomings of their rating systems. For example, they refer to their statistical measures as representing *indicators* of the unit's ability to accomplish its missions and as providing only an *assist* in resource allocation. Moreover, they permit an override of the statistical measures by judgmental analyses performed by the individual unit commander. However, the addition of judgmental analyses to overcome fundamental weaknesses still leaves much to be desired in getting at the question of *ready or not*.

Analysis of Military Organization Effectiveness was conceived and developed in 1976 to overcome the deficiencies described above. The approach possesses the following features:

- Combinations of both personnel casualties and materiel damage.
- Application of personnel casualties and materiel damage to a detailed anatomy of the organization's structure.

• A measure of effectiveness as a function of time after onset of some initial degradation.

• Treatment of time as a resource.

AMORE recognizes that military units can be represented as a set of like increments each contributing to mission accomplishment (see Figure 1). The dissection into increments is accomplished by a detailed study of the Table of Organization and Equipment or some other organizational representation of the units. The third box in Figure 1 represents the dissection of the unit into those increments or functional teams required for mission performance and an examination of each of the teams to determine which personnel and equipment in that team or increment are absolutely essential for mission accomplishment. Thus, hypothetically, the crew of an artillery battery might consist of six personnel, of which only four are actually essential for combat operation. This minimum complement of personnel serves to define a bare-bones element, referred to as a minimum essential team. Establishment of these elements requires very close coordination with user personnel. It should be noted that each team or increment invariably comprises both personnel and associated items of equipment.

Examination of the organization's anatomy and its dissection into teams is done concurrently with the determination of personnel and materiel damage combinations. Associated with each personnel skill and materiel type are different damage probabilities that stem from inherent differences in personnel postures and equipment vulnerabilities. To obtain damage probabilities, analysts use the universally accepted Joint Munitions Effects Manual methodologies. Then using a Monte Carlo technique, analysts choose a random number for each individual and piece of equipment. By comparing the random number with the input probabilities, they can divide personnel into two categories: survivors and casualties. Similarly, analysts can divide materiel into four categories: survivors, lightly damaged, moderately damaged, and severely damaged.

Figure 2. A typical transfer matrix for personnel in a hypothetical tank unit

This figure indicates which personnel can replace other personnel and the number of minutes it takes the substitute to assume and begin performing the secondary task. For example, a tank commander could immediately begin performing the tasks of a tank gunner or loader, but it would take 5 minutes for him to assume and begin performing the tasks of a platoon leader.

No degradation Some degradation

HQ PERSONNEL \ HQ TASKS	Commander	Technical officer	Warrant officer	Truck driver	Tank driver-mechanic	Tank gunner	Tank loader	PLATOON TASKS	Platoon leader	Tank commander	Tank driver-mechanic	Tank gunner	Tank loader
Commander	0			0			0		0	0			0
Technical officer		0											
Warrant officer			0										
Truck driver				0									
Tank driver-mechanic					0		9				0		10
Tank gunner						0	0			5		0	0
Tank loader						5	0					5	0
PLATOON PERSONNEL													
Platoon leader	10			0	6	0	5		0	0	6	0	5
Tank commander						0	0		5	0		0	0
Tank driver-mechanic					0		10				0		9
Tank gunner						0	0			5		0	0
Tank loader						5	0					5	0

A simulated attack causes some teams to lose essential members, rendering them incapable of performing their missions. The number of teams that remain operational—that is, can fire and move immediately after attack—is the measure of the unit's capability. To increase capability, the commander would have to reorganize and reconstitute essential teams. Thus, the regrouping of personnel and materiel so as to maximize the number of essential teams is one of the commander's main objectives. Another objective is to minimize the time required to reach maximum capability.

Regrouping or reconstitution requires one to know which individuals in the unit can be used or substituted in various skill areas and which items of equipment can be substituted for other items. Further, when feasible substitutions are made, one must consider the times to decide to substitute and the times needed to effect a substitution. With personnel, one also must consider the time it will take a replacement to become proficient at the new task. These and many other pertinent times are all considered so that the gradual buildup of unit effectiveness becomes expressible as a function of time.

A transfer matrix provides the means for indicating which tasks unit members can perform in addition to their standard ones, and the amount of time it normally takes for the individual to assume the new task, adjust, and begin performing it. Thus, a typical transfer matrix for personnel in a hypothetical tank company has a row and column for every skill type (see Figure 2 on p. 33). In this case, the numbers in the matrix represent the absolute minutes it takes to effect the transfer; in other cases, however, the time unit could be hours or days. It should be noted that similar matrices are devised for items of equipment.

The problem of unit reorganization becomes one of making optimal personnel and materiel assignments based on the transfer matrices to meet the commander's objective. AMORE uses a transportation algorithm because of the supply-and-demand nature of the problem and because all assignments must be integral.

The stochastic processes used in the methodology make a single iteration of the procedure insufficient.

Figure 3. The reactions of different units to battle damage

AMORE shows that when both a tank company and an artillery battery suffer a 50-percent casualty rate with associated equipment damage, the artillery battery's capability is more severely curtailed initially and its recovery is slower. When these same units incur a 30-percent rate of personnel incapacitation, the artillery battery is again less capable initially but recovers better than the damaged tank company.

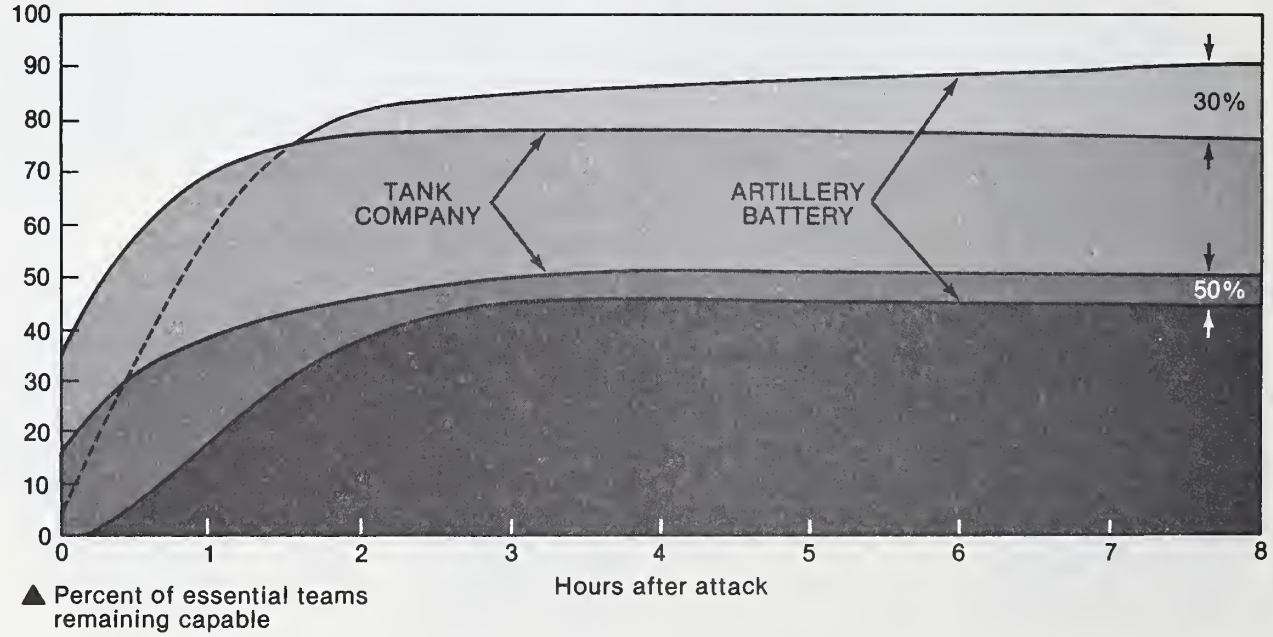
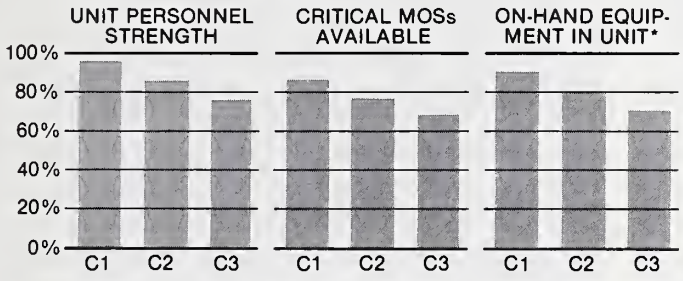


Figure 4. Current readiness criteria are poor indicators of combat capability

The Army applies the criteria depicted in the three graphs to the left to rate unit readiness. But AMORE shows that a team of tank companies could be reported in any of three readiness conditions and yet be equally effective.



*Or minimum level allowed by AR 220-1

	REDCON 1	REDCON 2	REDCON 3
Materiel teams	14-16‡	12-14	11-14
Personnel teams	16	16	13.7-16
Unit teams	14-16	12-16	11-16
Unit capability	88-100%	75-100%	69-100%
Overlap range	—	88-100%	88-100%

‡Maximum of 16 teams

Typically, 25 or more iterations are necessary before the average results converge within a statistically acceptable limit. A typical result is shown in Figure 3, in which unit effectiveness, in terms of number of teams, is plotted as a function of time. It should be noted that this figure clearly illustrates that different units inflicted with the same level of damage or attrition behave quite differently. Some units are more severly impacted initially than others. Similarly, different units recover to different levels and do so at quite different rates. The added dimension of the AMORE measure of effectiveness highlights many more facets of a unit's capability. It is therefore axiomatic that the results and conclusions obtained through the use of AMORE often differ in significant ways from those obtained through the mere use of attrition counts.

In addition to providing such curves, AMORE software offers a printout of those critical skills and items of equipment that prevent further increases in unit performance. The printout also reflects those skills that cause the longest delays in the reconstitution process. Moreover, it highlights those skills and items of equipment which rarely are used for transfer and which in effect represent a repository of surplus personnel skills and materiel.

The Army delineates its readiness or unit-status policy in AR 220–1, which outlines a system for reporting unit readiness condition (REDCON). The Army depends on this system for garnering information that is used in contingency planning and resource allocation. An application of the AMORE methodology was conducted in 1978 for the Army's Deputy Chief of Staff for Operations and Plans to examine the relationship of unit REDCON rating to unit ability to accomplish missions and the resiliency of that ability. Resiliency is defined as the ability of the unit to continue initial operations after having sustained varying levels of damage. Criteria for unit readiness condition ratings are outlined in Figure 4. To fall within a particular REDCON rating, a unit must have at least the minimum personnel and equipment percentages for that rating, as indicated in the figure. If it does not satisfy all the percentages, the lowest personnel or equipment category dictates what REDCON rating the unit receives.

Use of a simplified sampling procedure generated a population of units possessing personnel and materiel combinations that represented units in each of the first three REDCON states. The effectiveness of each of those units as a function of time was then determined by applying the AMORE technique. These units were then subjected to increasing levels of combat damage to assess the capability of units in particular readiness conditions to wage and sustain combat.

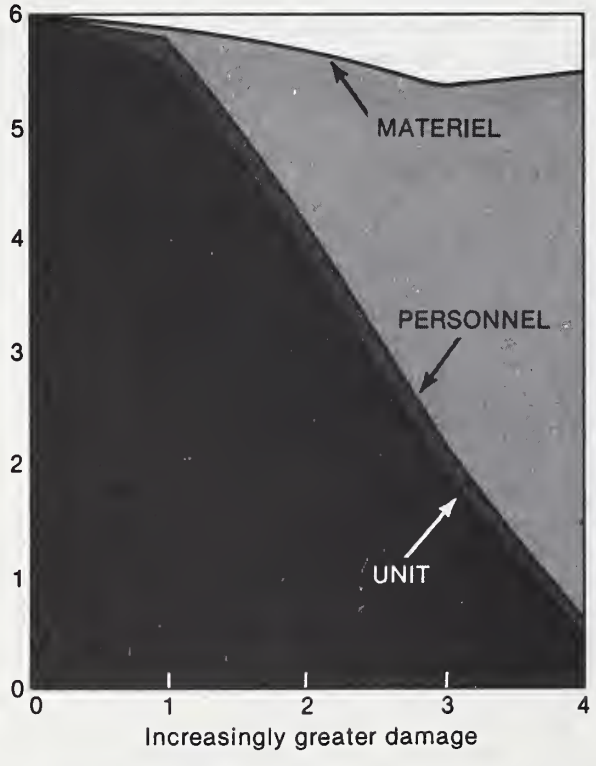
Figure 4 also portrays the number of teams or effectiveness increments determined by AMORE for a population of tank units in each REDCON state. According to the AMORE measure, tank units in REDCON 1 could range from 88-percent to 100-percent effective. The capability of units in REDCON 3 could range from 69 to 100 percent. Put another way, tank companies could be reported to be REDCON 1, 2 or 3, and nonetheless be equally ef-

fective. This finding was typical for all the units examined. Thus, the statistical readiness category ascribed in accordance with current policy to any given unit is a poor indicator of combat capability.

As to the question of unit resiliency, AMORE was used to examine the unit's effectiveness as the damage to a unit in a given REDCON gradually increased. Figure 5 shows such results for the combat-support company in a tank battalion as a function of increasing damage. The figure shows that the company's capability degrades sharply as damage intensities increase, meaning the unit is not very resilient. It also shows that the effectiveness of the unit for the mission under consideration is driven more by personnel than by materiel. This indicates that priority should be given to personnel replacements. Finally, the AMORE methodology identifies those personnel skills that should receive management's highest priority.

Figure 5. A support company's effectiveness relative to the degree of battle damage

AMORE shows that the capability of a combat-support company in a tank battalion degrades rapidly under battle conditions primarily because of personnel degradation. AMORE helps the commander identify those skills that deserve priority attention.



Results similar in nature to those mentioned above were obtained for all units studied and then were compared with capability ("C") ratings currently assigned to similar units. The AMORE methodology demonstrated that current readiness-reporting criteria are ambiguous, unbalanced, and poorly related to either peacetime readiness or combat sustainability. Moreover, current rating systems and associated procedures do not provide an efficient means of managing the allocation of available resources since the relative leverage of individual skills and items of equipment is not reflected in the systems. In essence, current rating systems are poor indicators of whether we are *ready or not* to fight, and they provide little assistance in identifying ways to improve the situation.

The existing shortfall appears correctable with a rather straightforward approach. It is suggested that the AMORE measure of effectiveness be used to establish unit-status criteria. Each commander will garner the information needed to develop an AMORE effectiveness curve for his unit. He will be required to dissect his unit and develop the associated transferability matrices. Then, either the commander, with the help of some simple algorithms, or some central authority can establish the number of teams or increments of effectiveness the unit can constitute. For example, if the unit can constitute 90 percent or more of the fully ready teams, it is placed in REDCON 1; if it can constitute between 80 and 90 percent, it falls in REDCON 2.

A readiness system based on the AMORE process and measure of effectiveness boasts a number of favorable attributes. It removes the ambiguity found in the current system in that any given REDCON assignment will ensure that a certain percentage of teams can be developed with the unit's remaining resources. Also, it produces a readily accepted measure since the user recognizes that the personnel, materiel, and time resources are treated in an integrated and credible manner. Moreover, it is a process that reflects the critical nature of individual skills and items of equipment that can be used for more efficient resource management.

The implementation of such a system also will go a long way toward explaining the gaps that often

Some recently conducted AMORE analyses*

- *Logistics System Survivability In a Chemical Warfare Environment.* Examines the impact of chemical-warfare degradation on the ability of logistics organizations to satisfy support requirements.
- *Analysis of Military Organizational Effectiveness for Tactical Air Readiness.* Determines a tactical squadron's sortie capability based on readiness-condition profiles and identifies what personnel skills and equipment are most critical to a high mission-readiness profile.
- *Analysis of the Interim Marine (Type) Battalion.* Determines the resiliency of type organizations and recommends remedial action.
- *Military Organizational Effectiveness for Readiness and Sustainability.* Examines the relationship between unit readiness and combat capability and measures the sustainability of battalion organizations.
- *Military Organizational Effectiveness of Forward Support Units.* Determines the impact of combat attrition on support capability, identifies critical personnel and equipment, and offers cost-effective options for improvement.
- *Impact of Scatterable Mines on Unit Combat Performance.* Examines the impact of mixing scatterable mines and improved capability munitions of Warsaw Pact tank and artillery batteries.

*Conducted by Science Applications, Inc.

exist between current statistical measures and judgmental analyses. While AMORE may not entirely remove the need for judgmental analyses, it will substantially reduce that need and provide a better basis on which to make judgments. Above all, it will tell us a lot more about the peacetime readiness and post-deployment performance of units.

In addition to being able to serve as a basis for a new readiness or unit status rating system, AMORE should be effective in measuring the combat capability of enemy units. Historically, our net assessments have been based primarily on comparisons of rudimentary *bean and attrition* counts. Several blue-red comparisons conducted with AMORE have revealed some rather significant and surprisingly favorable differences in the capabilities of corresponding combat units, especially with respect to post-deployment performance.

Certainly, the need to consider personnel and materiel in an integrated manner and to incorporate the time resource in our measures of effectiveness is long overdue. The ability to do so provides a new dimension to the measurement of unit effectiveness and facilitates the examination of many problems that previously have defied adequate treatment. AMORE represents the successful development of such a measure. The repeated applications of the AMORE method these past four years are clear evidence of the acceptance the approach has already earned.

In addition to having been used as a basis for readiness ratings, AMORE has been used on problems involving survivability, force structuring, training, doctrine, tactics, logistics, and personnel replacement. Many of the insights on peacetime readiness gleaned through AMORE applications on units of up to battalion size have been aggregated to obtain measures for brigade, division, corps, and theater forces. This should be of special interest to those managers responsible for the provision and allocation of resources.

The use of AMORE to date represents a modest beginning and only scratches the surface of the volume of tasks that cry out for such a tool. The initial efforts have been completed and a core of expertise in its use has emerged. Resorting to the same old techniques and measures is neither necessary nor warranted. Today, we are in a much better posture to measure unit combat effectiveness and to use these measurements to develop a readiness rating system that will offer credible answers to the question of whether we are ready or not. DMJ

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Mr. Golub conceived and developed AMORE while under contract to Science Applications, Incorporated. He gratefully acknowledges the help of key members of the firm's Military Requirements Operation who contributed to the development of the basic concept and system software.

The continuing need for mission area analysis

By DAVID L. BROWDER and PATRICK J. SWEENEY

Justification for developing a new weapon system greatly hinges on the extent to which the proposed system will complement existing and anticipated components of the force structure.

In April 1976, the Office of Management and Budget and the Office of Federal Procurement Policy issued OMB Circular No. A-109, a new policy for the acquisition of major systems for all Executive-branch agencies. Intended to effect reforms that will reduce cost overruns and diminish the controversy on whether new systems are needed, A-109 requires a continuing analysis of present and forecasted mission capabilities, technological opportunities, national priorities, and resource constraints.

When this analysis, formally known as a mission area analysis, identifies deficiencies in existing capabilities or opportunities to establish new capabilities in response to a technologically feasible alternative, they will be documented in the form of a mission element need statement. This need statement includes the purpose and capability of the mission, which agencies would be involved, time and operating constraints, and the value of meeting the need relative to other requirements.

The purpose of the A-109 policy is not to express a need in terms of specific equipment which might satisfy a deficiency, but to allow all technologies and concepts to at least be considered before system choices are narrowed.[1] Additional mission area analyses are then conducted throughout the life cycle of the system to identify new opportunities and deficiencies. The entire process of analysis is an iterative one.

In effect, A-109 formalizes the system acquisition process. William Perry, former Under Secretary of Defense for Research and Engineering, wrote, "It is clear that the OMB and the budget committees of the Congress view the MENS (mission element need statement) as a key document of the acquisition process." He added, "The major weapon system acquisition process would hinge on an ability to *conduct* and *present* rigorous mission area analysis as the basis for establishing mission deficiencies and needs."[2] Thus, the MENS is intended to ensure that any acquisition issues requiring debate by Congress come to light before the commitment of major resources and the selection of solutions. The MENS also indicates how the proposed system will mesh with the other major systems within the same mission area to contribute to national security objectives.

The strategic offense mission area analysis offers a good foundation for system advocacy. In 1967, Harold Brown stated, "Advocates of a follow-on bomber to replace the B-52 must give a convincing demonstration of the system's operational utility within an overall national defense strategy." He went on to state, "Only such a compelling reason is justification for going ahead (with production)." In 1977, Secretary of Defense Brown again insisted on such analyses to support initiation of the B-1 production program. When analyses did not sufficiently support production of the B-1 vis-a-vis the cruise missile or the MX, the B-1 program was cancelled.

To support the acquisition of new strategic systems, one must consider three integral elements in the strategic mission area analysis:

[1] *Office of Federal Procurement Policy, A Discussion of the Application of OMB Circular No. A-109, August 1976.*

[2] *DoD Memorandum, "Mission Element Need Statement," January 18, 1978.*

- An analysis of U.S. national policy regarding strategic offensive forces and the requirements that stem from such a policy.
- An analysis of all potentially technologically feasible alternatives and their relative contributions.
- The integration of the previous two elements with respect to time.

National policy

Our national policy makes deterrence of war a primary strategic objective. U.S. armed forces are the instruments through which this national policy is implemented. Our strategic offensive forces are particularly important in this deterrence role and must be capable of operating across the conflict spectrum. The current components of this force are long-range bombers, aerial refueling tankers, land- and sea-launched strategic missiles, and systems for command and control. For these forces to deter conflict or to prevail if deterrence fails, they must possess certain characteristics, including:

- *Survivability* to endure through benefit of early warning, quick reaction, dispersal, or mobility.
- *Penetrativeness* to ensure access to all necessary and desired targets.
- *Striking power* to ensure target destruction.
- *Reconnaissance* to ensure the detection of unforeseen or missed targets.
- *Re-strike capability* to force a conclusion to hostilities during a protracted war.
- *Flexibility* to provide deployment options and tailored responses.
- *Reliability* to ensure the highest degree of confidence from force execution to detonation of weapons on target.
- *Command, control, and communications* to ensure effective force management under all possible conditions.[3]

Because no single weapon system boasts all the required characteristics, there is a continuing need for a mix of weapon systems. Clearly, the acquisition of a weapon system must be justified on the basis of the system's relative contribution to the total strategic-force capability to implement national policy.

The strategic offense mission area encompasses both the central conflict, which includes a range of mission options consisting of nuclear alternatives, and the theater conflict, which includes nuclear, conventional, and collateral missions. The many possible scenarios that could arise within the strategic offense mission area must receive a great deal of attention when mission requirements and technological opportunities are being identified. Traditionally, strategic offense-related analyses have addressed only the major attack options of the single integrated operational plan. Such analyses give inadequate analytic treatment to system trade-offs and long-term implications of the total U.S. strategic doctrine.

The evolution of U.S. national strategic policy is best illustrated by the recently released and highly publicized Presidential Directive 59. This directive clearly prescribes that the president have multiple options available to him regarding the use of nuclear arms. The issue of a multifaceted strategic employment policy has been under study for ten years; however, only recently have the implications of such a policy been identified.

Since 1957 a strategic doctrine has been evolving that offers the nation a broader range of options for the employment of nuclear weapons to accomplish political objectives. In a 1978 speech, Harold Brown stated, "It would be a mistake to leave a potential enemy with the prospect that, if faced with a controlled and limited attack, we would have only the options of an all-out response or no response at all."[4]

Consequently, analyses that address any leg of the TRIAD must consider the mission characteristics and the full range of threats to which the weapon system may be exposed. Current Air Force analyses of the aeronautical leg of the TRIAD have led to the *scenario groups* concept for solving this problem. Although these analyses have considered only current and near-term weapon systems, they serve as a good baseline for increased consideration of broader technological alternatives. It is important to note that mission analysis of the strategic offense mission area cannot be done for just a few representative or paradigm scenarios if it is to be considered complete. Key system-effectiveness requirements for the spectrum of possible scenarios must be identified through conscientious analysis.

[3] *"Strategic Offense,"* USAF and force employment readings, *Vol. 2, Air University, Maxwell AFB, Alabama, March 1976.*

[4] *Harold Brown, Speech to Council on Foreign Relations, New York, September 1978.*

Clearly, system capabilities must not be allowed to dictate policy. Instead, all policies and strategies must be analyzed in the context of national objectives. Mission area analysis is the continuing process by which this is accomplished.

For purpose of illustration, assume that deterrence fails and the United States is forced to retaliate with nuclear weapons. The single integrated operational plan provides for graduated actions by the president, but these are options that were formulated months or years earlier.[5] Unfortunately, it is impossible to predict the circumstances leading to the employment of the strategic offensive forces; consequently, various command authorities now desire a more dynamic force-management capability.

The development of such a capability affects not only the single integrated operational plan, but all the constituent systems involved in its execution as well. These systems include, but are not limited to, the land-launched intercontinental ballistic missiles, submarine-launched ballistic missiles, manned bombers, and all the supporting strategic command, control, communications, and intelligence systems. Any intention to flexibly employ even one element of one of these systems affects other requirements throughout the mission area. Only a total strategic offense mission area analysis could identify the level of systems interaction and the resulting requirements.

Technological opportunities

Another serious issue today involves the direction that U.S. technology programs should take to support future strategic offensive systems. The rapidly growing cost of research and development, coupled with scarce funds, dwindling supplies of manpower, and increasingly complex weapons, has highlighted the importance of identifying meaningful technology programs. Clearly, budget constraints dictate the funding of only the most essential technologies. Consequently, there must be a sustained effort to match forecasted mission deficiencies with technological opportunities. This process must provide a cohesive framework within which all potential technology alternatives are identified and examined for feasibility early in the acquisition process.

Strategic offense mission area analysis serves this purpose. Such a tool allows the military services to convey projected shortcomings in current and planned system capabilities as well as evolutionary trends in employment policy. It also allows the developing agencies to integrate offense-related technology development programs for air, land, and sea systems to meet those projected deficiencies. Without such an analysis, strategic-system technology-development programs would be forced to compete for research-and-development funds without any true perspective of each program's relative contribution.

Any new or continuing development program will have to justify its existence based on a strategic offense mission area analysis. Only through such a thorough exercise can the elements of national policy, technology, and time be effectively integrated.

Requirements for systems that will facilitate more dynamic force management are just now being established. Several technologically feasible alternative systems are being pursued in isolation and in absence of creative insight as to the impact of their intertwined system requirements on the strategic force architecture. For example, an offensive avionics system for the B-52G and B-52H is being developed by the Air Force. Concurrently, an Air Force satellite communications terminal is being installed in these B-52s, in national command-post aircraft, and in post-attack command-and-control aircraft.

Essential to flexible force management is global, survivable, two-way communications between the command post and the force elements. Had strategic offense mission area analysis been ongoing, decision makers possibly would have been apprised of the possibility of using the satellite system as the near-term means for more efficient, flexible force management. Then, if deemed critical to total-force management, the satellite-communications terminal could have been integrated into the avionics multi-

[5] *Mark D. Mariska, "The single integrated operational plan,"* Military Review, *Vol. 52, March 1972.*

plex system so that information such as fuel on-board, weapons delivered, and bomber location could be transmitted automatically from the aircraft. Instead, the terminal is being installed as a stand-alone system located at the gunner's station.

Far-term, survivable, two-way communication could be provided by an extremely high frequency strategic satellite system, but the strategic system program office has been aware of an aircraft flexible-employment requirement for satellite support for only the past few months. Strategic offense mission area analysis helps strategists to identify such requirements and to integrate strategic mission-related development activities.

Integration with respect to time

Often the future is dissected into discrete segments of time to facilitate analysis, planning cycles, and budgeting. This snapshot approach cannot be used during mission area analysis, for it is necessary to recognize the fluidity of time and the fact that major weapon systems are not developed in a vacuum. The recently completed *Strategic Bomber Study* suggested that the minimum time from request for proposal to initial operational capability for a new strategic bomber would be ten years; and for the B-1, 13 years.[6]

There must be a sustained effort to match forecasted mission deficiencies with technological opportunities. This process must provide a cohesive framework within which all potential technology alternatives are identified and examined for feasibility early in the acquisition process.

The most recent Air Force Scientific Advisory Board concluded that only through the modification of B-52s or FB-111As, or through adoption of an airframe and engines of a system now in research and development, such as the B-1 bomber, could this minimum lead time be reduced. During this relatively lengthy period, there is considerable possibility of evolution in threat, technology, military posture, and strategic doctrine beyond what was anticipated when the programs were begun. As more knowledge of needs, alternative solutions, actual capabilities, resources, and priorities is acquired, some aspects of the analysis should be iterated. Once a mission analysis has been performed, an audit trail is established. The capability to reevaluate new information as it is identified allows strategists to make timely decisions with an understanding of what went on before.

Thus, the first step of a strategic offense mission analysis should be an inventory of existing strategic systems and on-going development programs. The mission analysis should then reconcile chronologically these programs with pertinent DoD development goals. The recognition of interrelated system requirements and a time phasing of capabilities are necessary to achieve strategic offense force enhancements required for the 1990s and beyond.

The acquisition procedure prescribed in OMB Circular A-109 is not likely to disappear soon. Any new or continuing development program will have to justify its existence based on a strategic offense mission area analysis. Only through such a thorough exercise can the elements of national policy, technology, and time be effectively integrated. Strategic offense mission area analysis can provide the direction of and rationale for the future strategic force. Indeed, the need for strategic offense mission area analysis is a continuing one that is applicable to all future strategic systems. DMJ

[6] *"Strategic Bomber Study," General Research Corporation, May 1979.*

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The underlying theory of incentive contracting

By RICHARD F. DEMONG and DANIEL E. STRAYER

By assuming that profit is the corporate manager's primary goal, DoD may be overlooking other equally effective motivators that could prove to be less costly.

It is stated in *Genesis* that where discretion exists it is apt to be exercised, and that to merely charge someone to be a good and faithful servant is not adequate to secure his performance.[1]

The Department of Defense attempts to secure performance by writing contracts that limit a contractor's discretion in the acquisition process. Thus, if the contractor had limited discretion with regard to the system's cost and final performance but more discretion concerning the delivery date, the DoD contracting officer might add a delivery-date incentive to encourage early delivery.

At present, almost one-third of the total dollars awarded by DoD in large contracts ($10,000 or greater) are awarded in incentive contracts and award-fee contracts (see Figure 1, p. 45). Another 40 percent are awarded in firm-fixed-price contracts. But if the contracts are measured by the number of actions rather than by the total value of awards, the percentage of contracts that include an incentive or award fee drops to 4.1 percent and the percentage that include a firm fixed price leaps to 78.2 percent.[2] Thus, very large awards are more likely to include incentive-fee provisions in their contracts than are smaller awards. Conversely, smaller awards are more likely to have fixed prices.

The extensive use of incentive contracts and firm-fixed-price contracts can be directly traced to the early 1960s, specifically to the efforts of former Secretary of Defense Robert S. McNamara. However, incentive contracts are by no means a contemporary innovation. Both the *Monitor* of the Civil War and the Wright brothers' "heavier-than-air machine" were purchased under an incentive contract. The *Monitor* had to float, attain a specified minimum speed, and win its first battle before the contractor was paid. The Wright brothers received a $5,000 bonus in addition to their $25,000 contract when their flying machine exceeded the target speed by more than two miles per hour.[3]

The Department of Defense relies on two concepts to limit the discretion of the contractor and to encourage the contractor to make trade-offs that benefit the government. First, the contract legally requires certain actions and prohibits others. Second, DoD expects the profit goal to motivate the contractor to complete the contract in a manner that is beneficial to the government. As the Defense Acquisition Regulation states:

Profit, generally, is the basic motive of business enterprise. . . . The objective should be to insure that outstandingly effective and economic performance is met with high profits, mediocre performance by mediocre profits, and poor performance by low profits to losses.[4]

Incentive contracting in turn is based on DoD's belief that profit effectively motivates businesses. As DoD's somewhat dated *Incentive Contracting Guide* states:

The profit motive is the essence of incentive contracting. Incentive contracts utilize the drive for financial gain under risk conditions by rewarding the contractor through increased profit for attaining cost (and sometimes performance and schedule) levels more beneficial for the government than expected (target) and by penalizing him through reduced profit for less than (target) expected levels.[5]

However, the *Guide* also recognizes that other extracontractual factors can be significant motivators. These include growth; new product lines; prestige; an improved public image; social approval; national goals; potential for follow-on businesses; commercial applications; excess manufacturing, engineering, or labor capacity; increased profits on other contracts through shared overhead; and excelling for the sake of excellence.

According to the *Incentive Guide*, DoD "recognizes that contractors will, generally, optimize—not maximize—profit." This follows Herbert A. Simons' theory that a decision maker cannot possibly know all possible options; at best he or she can only satisfy goals, not maximize them.[6] The *Guide* recommends that when nonprofit motives are apparent, they should be considered when structuring incentive contracts. But this recommended use of extracontractual motivators is limited since such fac-

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[1]Genesis, *Chapters 3 and 4*.

[2]Military prime contract awards: fiscal year 1978 *(Washington, DC: Department of Defense), p. 64*.

[3]*David Leigh Belden, "Defense procurement outcomes in the incentive contract environment," Doctoral dissertation, Stanford University, 1969, pp. 4, 8–9.*

[4]Armed services procurement regulation *(Washington, DC: U.S. Government Printing Office, 1976), p. 3–22*.

[5]*DoD and NASA,* Incentive contracting guide *(Washington, DC: U.S. Government Printing Office, October 1969), pp. 1–2*.

[6]*Herbert A. Simons, "Theories of decision-making in economics and behavioral science,"* American Economic Review, *June 1959, pp. 253–283*.

ILLUSTRATION BY HUGH BROWN

tors are often beyond the control of the U.S. government. Their recommended use has not been incorporated into the Defense Acquisition Regulation in any significant manner.

Thus, DoD's basic position is that in order for incentive contracting to be effective, defense contractors must be motivated by extra profits. An economist might say that the company's goals should be profit maximization. Merton J. Peck and Frederic M. Scherer go a step further: "It is generally assumed that a major objective of contractors is to maximize profits, presumably by maximizing the price stated in a contract, and that these profit-maximization efforts conflict with the government's goal of minimizing weapons cost."[7]

However, many observers question the importance of profit maximization to the average American company. Notably, extensive research has shown that incentive contracts are not as effective as expected.[8] These two observations may be related.

What then is the relationship between the profit-maximization goal and the incentive contract? Moreover, what are the economic foundations and managerial infrastructure of incentive contracting?

The theory of the firm

The classical economic explanation of the motivations of the business corporation is given by the theory of the firm. According to this theory, the entrepreneur's ultimate aim is the maximization of profits, where profits are defined as total revenues minus total costs.[9] This assumes that the manager can vary both the output of the firm and the total costs. It also assumes perfect competition, which in economics implies the following conditions:

- Homogeneous commodity.
- Numerous buyers and sellers.
- Perfect information about prevailing prices and bids.
- Entry into and exit from the market that can be accomplished in the long run.[10]

These conditions usually are not met in the typical business transaction. Generally, buyers and sellers will deal with a differential product with less than perfect information about prevailing prices and bids. And since it is not unusual for there to be relatively few firms in control of any one market, there are not necessarily numerous sellers, and entry into a market may be very difficult.

In typical business-government transactions, even fewer of these conditions are met. Often in a major system acquisition almost all conditions are violated. There is generally a customized product such as a fighter aircraft or aircraft carrier. There is only one buyer—the U.S. government. Only the buyer has information about prevailing prices and that is only after the proposals are received. And gaining entry into the manufacture of major weapon systems is very difficult indeed.

There are, however, some business-government transactions where many of these conditions, if not all, are met. For example, when the government purchases such commercial items as paper clips, the assumptions of the theory of the firm may be met. However, in most major acquisitions, including those involving service contracts and research and development, the assumptions are clearly negated simply because there is only one buyer. In addition, there is often but one source of the product. This situation of one buyer and one seller (bilateral monopoly) clearly violates the major assumption of perfect competition. The situation of a few sellers, like the shipbuilding and aircraft manufacturing industries, also violates the economic definition of a competitive market even though DoD would assert that the market is competitive because there is more than one bidder.

[7] *Merton J. Peck and Frederic M. Sherer,* The weapons acquisition process: an economic analysis *(Boston: Harvard University Press, 1962), p. 457.*

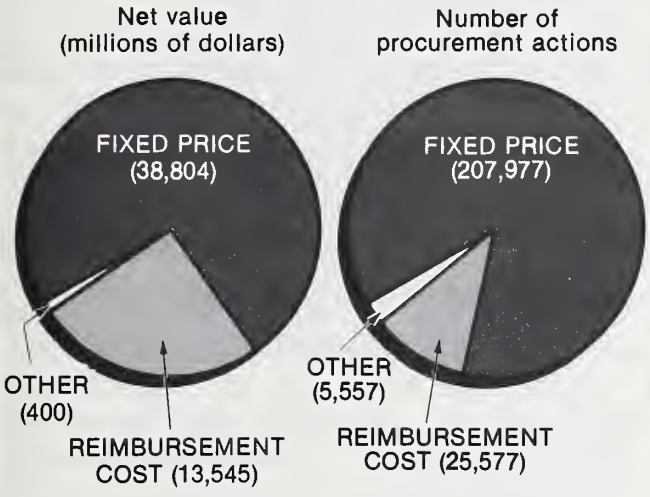
[8] *Richard F. DeMong, "The effectiveness of incentive contracts: what research tells us,"* National Contract Management Quarterly Journal, *December 1978, pp. 12–22.*

[9] *James M. Henderson and Richard E. Quandt,* Microeconomic theory: a mathematical approach *(New York: McGraw-Hill Company, 1971), Chapter 3.*

[10] *Ibid., p. 104.*

Figure 1. The net value and number of procurement actions for various types of large contracts let by DoD in FY 1978

If all DoD contracts valued at more than $10,000 are measured by the number of procurement actions rather than the total value, contracts that include a firm fixed price account for more than three-fourths of all awards let in fiscal year 1978.



Contract type	% of Net Value	% of Procurement Actions
FIXED PRICE	73.6	86.9
Firm	39.6	78.2
Redeterminable	1.8	1.5
Incentive	19.9	2.4
Escalation	12.3	4.8
REIMBURSEMENT COST	25.7	10.7
No fee	2.2	1.6
Fixed fee	10.8	7.4
Incentive fee	9.7	1.2
Award fee	2.9	0.5
OTHER	0.8	2.4
Time and materials	0.6	1.7
Labor hours	0.2	0.7

Source: Military Prime Contract Awards: Fiscal Year 1978 (adjusted)

Firm behavior without perfect competition. What theory then explains the behavior of firms in an imperfectly competitive setting? Unfortunately, there are no generally accepted behavioral assumptions outside of perfect competition except in monopoly (one seller and many buyers) and monopsony (many sellers and one buyer) market conditions. Under bilateral monopoly (one buyer and one seller) conditions, there are three general outcomes:

- One of the participants dominates and forces the other to accept his price and quantity decisions (the government intentionally tries to avoid doing this).
- The buyer and seller collude or bargain to set price and quantity.
- The market mechanism breaks down.[11]

Generally, DoD attempts to negotiate contracts with a sole source under the second outcome, even though the quantity decision is generally set by the government. However, there are numerous examples where the other two outcomes have prevailed. In some cases the government has dominated the price and quantity decision. In others, due to superior or more experienced negotiators, the suppliers have dominated the pricing decision. In yet other instances, the market mechanism has broken down, and price and quantity decisions were arbitrarily set.

Since the assumptions for perfect competition are generally violated in business-government transactions, the theory of the firm does not necessarily provide a reasonable explanation for the behavior of industrial suppliers. Under conditions of less-than-perfect competition, the entrepreneur is given more managerial discretion to satisfy goals other than profit maximization. As will be seen, there are other reasons as well why a contractor may not behave as a profit maximizer.

Profit motive. Just how strong is the profit motive? Robert N. Anthony stresses that managers strive for satisfactory rather than maximum profit. He argues that this is because profit maximization is extremely difficult to achieve in practice and is sometimes immoral as well.[12] It is exceedingly dif-

[11] *Ibid., p. 244.*

[12] *Robert N. Anthony, "The trouble with profit maximization,"* Harvard Business Review, *November-December 1960, p. 129.*

ficult to apply the marginal pricing, where each price is set at the point where marginal cost equals marginal price, when selling and advertising costs and changing volume are factored into the equation. Even a government contractor with all of the cost information available from the mandatory detailed cost analysis will base a price on the total costs derived from the company's cost-accounting system rather than on marginal income and costs.

Profit maximization may also lead to immoral decisions that would clearly not be acceptable to corporate managers. For example, profit maximization might encourage the contractor to take every possible shortcut not prohibited by the contract. If this meant future performance problems that could endanger a soldier's life or the national security of this country, a contractor would not even consider such steps.

The profit-maximization theory works well in the classroom, where real-world problems can be filtered out through assumptions, but it does not work well in practice. Nor does it consider that managers are personally motivated by many factors other than profits and incentives. At best, managers will only indirectly benefit from extremely high profits or incentive.

As Fritz Machlup stated in 1967, "Maximization of money profits is certainly the simplest *objective function,* but it works only in the case of firms exposed to vigorous competition."[13] In other cases, managerial discretion makes managerial and behavioral theories more significant. Thus, profits may be important in many DoD contracts where there is vigorous competition, but other managerial and organizational factors may be equally important in major system acquisitions where there is less competition.

Harvey Leibenstein incorporated these managerial and psychological factors into microeconomic theory.[14] He calls the individual manager's level of effort the "x-efficiency" factor. This factor decreases directly with competition and ownership control and inversely with adversity.

Even with a profit-sharing plan or bonus plan, the effects of an extremely high profit on one contract or product will probably be diluted because they will quite often be shared with other managers who may not even be directly involved with the profitable product. This dilution decreases the effectiveness of profits as an incentive. In the organizational-behavior literature, it is well established that the higher the relationship between individual effort and reward and between individual effort and performance, the higher the motivation.[15, 16, 17] For profit to be a motivator, there needs to be a direct link between corporate or project profits and rewards for the project director and other decision makers, including the engineers and production managers. Unfortunately, due to the typical length of projects, this direct relationship is diluted at best.

Managers are influenced by many immediate concerns, including employee morale, production schedules, company vitality, and self-perpetuation. These goals outweigh the firm's goal unless they are operationalistic. In that case, the firm sets such goals as levels of profit, sales production, cost, and quality that managers are expected to achieve. Since these are *a priori* goals, they tend to be satisfactory rather than maximum and therefore attainable. Just by setting multiple goals, the firm is encouraging the manager to make trade-offs on the stated and unstated goals of the firm. Thus, the manager is encouraged to satisfy as many goals as possible.

On the other hand, the fact that profit maximization is not the only goal or even the primary goal of the firm does not mean that contractors are not motivated by profits. What it does mean is that there

[13] *Fritz Machlup, "Theories of the firm: marginalist, behavioral, managerial,"* American Economic Review, *March 1967, p. 22.*

[14] *Harvey Leibenstein,* Beyond economic man *(Boston: Harvard University Press, 1976), Chapter 5.*

[15] *John W. Atkinson,* An introduction to motivation *(New York: Van Nostrand Reinhold Company, 1964), pp. 238–239.*

[16] *Edward E. Lawler III,* Motivation in work organizations *(Monterey, CA: Brooks/Cole Publishing Company, 1973), pp. 47–49.*

[17] *Victor H. Vroom,* Work and motivation *(New York: John Wiley & Sons, Inc., 1964), pp. 204–209.*

are other motivators that the government could use in its contracting with private firms.

Managerial discretion. The theory of the firm assumes that the decision maker of the corporation is an entrepreneur—that is, the owner-manager. Yet it has been clearly established that the managers of most large corporations in America are not the owners. In 1932, Adolf A. Berle, Jr., and Gardiner C. Means found that only 11 percent of the 200 largest corporations in the United States were controlled by individuals or a small group that had more than 50 percent of the stock.[18] Another 33 percent of those corporations were controlled by a small group of investors that held more than 20 percent but less than 50 percent of the stock. More recently Larner confirmed this separation of ownership and control.[19]

Many observers question the importance of profit maximization to the average American company. Notably, extensive research has shown that incentive contracts are not as effective as expected.

In 1776, Adam Smith stated that managers who are not owners would be less efficient than owner-managers. He argued that the managers of other people's money would be less concerned than if it were their own. He went on to argue that "negligence and profusion, therefore, must always prevail, more or less, in the management of the affairs of such a company."[20]

Modern students of business behavior use kinder words to describe the behavior of managers. The behavioral theories assume rational actions on the part of managers, but those actions are based on the need to satisfy other goals besides profit maximization. In any case, it is important to examine behavioral theories of the firm to better understand the management of government suppliers.

Besides the theory of the firm, there are two primary sets of theories that attempt to explain the behavior of the business enterprise. The holistic theories assume that the firm acts as a single entity with homogeneous behavior.[21] These theories implicitly assume that a central force directs all individual actions of the firm's managers. This strong goal orientation is reflected in top management's directions and directives, which in turn are followed by all of the firm's decision makers. The behavioral theories assume that all of the managers will individually determine the objectives of the firm. These individual actions will be constrained by the organization's goals, but will not necessarily reflect those goals precisely. Top management can influence but not necessarily dictate the firm's behavior, since that behavior depends on the composite actions of many individuals.

All firms have some characteristics of a holistic organization, where all managers speak with one voice, but all firms also have some behavioral characteristics, where each manager can exercise some discretion in interpreting the needs of the organization. The firms differ in degree of control over the managers. Thus, even in a tightly controlled, centralized organization, behavioral theories are important because there always remains some degree of freedom for managerial discretion.

The formation of the firm's goals

The goals of the firm evolve from the top management of the company. Goal formation is influenced by the needs of the shareholders and other internal and external groups.

Most prominent among the internal groups are the managers themselves. Gordon Donaldson sees managers as a whole aspiring to continuity and growth, not to profit maximization.[22] The continuity of the firm and more directly the continuity of the manager's own job are often most important to the indi-

[18] *Adolf A. Berle, Jr., and Gardiner C. Means,* The modern corporation and private property *(New York: Commerce Clearing House, Inc., 1932), p. 115.*

[19] *Robert J. Larner,* Management control and the large corporation *(New York: Dunellen Publishing Company, Inc., 1970), p. 780.*

[20] *Adam Smith,* The wealth of nations, *edited by Edwin Cannan (New York: The Modern Library, 1937), p. 700.*

[21] *George C. Philippatos,* Financial management: theory and techniques *(San Francisco: Holden-Day, Inc., 1973), pp. 22–24.*

[22] *Gordon Donaldson, "Financial goals: management vs. stockholders,"* Harvard Business Review, *May–June 1963, p. 129.*

vidual decision maker. Other influential internal groups consist of the employees and their representative union.

The managers must also balance the needs and interests of external groups, including customers, suppliers, government regulators, trade and professional associations, and shareholders, against the needs of the internal groups. Thus, the profit-maximization goal of the shareholders is but one of many competing goals of the organization. The other long-term goals of the firm include sales and asset maximization, enhanced product quality, good community and employee relations, customer and supplier loyalty, a sound technological base, a decent corporate image, and an improved market share.

It is not clear whether the lack of competition or the separation of ownership and control leads to managerial discretion. Still, according to Furubotn and Pejovich, both conditions have an effect on the profit-maximization goal.[23] They agree with Williamson[24] when they conclude that "the general consequence (of the separation of ownership and control and negative-sloping demand curve) is that the managers are able to pursue their own goals within certain limits and, thus, tend to direct the firm away from the profit-maximizing position that represents the owners' desideratum."

If profit is not the primary motive of a corporation, what is? William T. Baumol suggests that the firm's primary objective is the maximization of sales or the rate of growth of sales.[25] Baumol argues that declining sales may cause the customers, distributors, and bankers to shun the company and its products. A good example of this phenomenon is the negative reaction to the Chrysler Corporation's declining automobile sales. Chrysler has had to offer rebates and numerous assurances that it will not fail simply to get its potential customers into the showroom. Baumol treats profits as a constraint that must be fulfilled.

Oliver E. Williamson argues that the manager will strive to maximize his or her personal utility. According to his theory, when the natural constraints of owner control and vigorous competition are absent, the manager's actions will reflect his or her individual interests, such as increasing staff size and various financial rewards.[26] Michael Jensen and William H. Meckling hypothesize that managers will also increase their nonpecuniary benefits, such as office space, air conditioning, and carpeting.[27] With both Williamson's and Jensen and Meckling's theories, as with the sales-maximization theory, profit is a minimum constraint that should be satisfied. In perfect competition, Williamson's theoretical solution approaches profit maximization.

Finally, Robin Marris theorizes that firms will attempt to maximize the growth rate of the demand for the firm's products and of the firm's productive capacity. As with the earlier theories, Marris's model uses a target rate of return or a minimum profit level that is consistent with a balanced, long-run growth rate. Profits are necessary both for survival and growth, and growth is often necessary for survival.[28]

To some extent, many of these goals lead to profits. However, in many cases these other goals will cause profits to drop. Good employee relations may increase the cost of production. Maximizing sales or market share may require that the goods and services be sold below their marginal or average cost. A recent case in point is Sears, Roebuck and Com-

[23] *Eirik G. Furubotn and Svetozov Pejovich, "Property rights and economic theory: a survey of recent literature,"* Journal of Economic Literature, *December 1972, p. 1149.*

[24] *Oliver E. Williamson,* The economics of discretionary behavior: managerial objectives in a theory of the firm *(Englewood Cliffs, NJ: Prentice-Hall, Inc., 1964), Chapters 2 and 4.*

[25] *William J. Baumol,* Business behavior, value and growth *(New York: The Macmillan Company, 1959), Chapter 6.*

[26] *Oliver E. Williamson, Chapters 4 and 5.*

[27] *Michael C. Jensen and William H. Meckling, "Theory of the firm: managerial behavior, agency costs and ownership structure,"* Journal of Financial Economics, *September 1976, pp. 312–330.*

[28] *Robin Marris,* The economic theory of "managerial" capitalism *(New York: The Free Press of Glencoe, 1964), Chapters 6 and 7.*

pany. The company attempted to regain lost market share by having increased promotions and sales. This strategy succeeded in raising the company's market share, but it also lead to a drop in earnings per share.

A firm may also have a series of short-term goals that complement its long-term objectives. Examples of short-term goals may be a certain level of production, employment, cash flow, or research and development.

Some mitigating factors

From all of the literature that we have reviewed, we can conclude that the theory of profit maximization has been attacked from three perspectives: the separation of ownership and control, the lack of pure competition, and the impossibility of maximizing. The behavioral studies of management also call into question the primacy of the profit-maximization goal.

Multiyear contracting would enable the contractor not only to spread the overhead costs over a longer period of time, but also to increase the firm's perpetuation. This risk reduction would encourage the contractors to lower the level of satisfactory profit (and thus the price) on any one contract.

Still, one must keep in mind several mitigating factors that ensure that firms have at least a minimum-profit goal. First, the capital markets may indeed influence managers to act in the owners' interest. This effect may be influenced by the fact that much of the managers' total compensation is in the form of returns from presently owned stock and from capital appreciation of the value of their stock options.[29, 30, 31] The capital markets may also act as an effective constraint on the top managers because of a fear of takeover by unsympathetic owners if the present shareholders' objectives are not met.[32, 33] The diffused ownership permits greater specialization among the shareholders, according to De Alessi. This in turn induces better-informed owners to react sooner and more accurately to an inefficient operation, thereby lowering the stock's market price and cost of taking over the firm.[34]

The second constraint on the behavior of management is the competition within the marketplace, which tends to eliminate inefficient firms with high managerial costs or nonprofit goals.[35, 36]

Finally, the third constraint that appears to be operational, according to De Alessi, is internal competition among the managers within one corporation. As the individual managers vie for promotions and pay increases, they will attempt to maximize the measurable objectives of the corporation, one of which will be profit.[37]

Applying alternative theories to DoD

The preceding economic and behavioral theories apply to firms in general, but do they apply specifically to DoD contractors? The answer is yes. Government-contractor relationships have some unique characteristics, such as government-supplied equipment, but defense contractors generally tend to behave like all commercial firms.

Professor Raymond C. Hunt of the State University of New York at Buffalo conducted a thorough and rigorous analysis of the economic motivations of contractors in 1971. After reviewing the literature and surveying the questionnaires and interviews, Hunt concluded:

If we had to identify a single over-arching company motive. . . (at least of the R&D corporation participating in this research) it would not be profit-

[29] *Wilbur G. Lewellen, "Management and ownership in the large firm,"* Journal of Finance, *May 1969, pp. 299–322.*
[30] *Fritz Machlup, p. 20.*
[31] *Robert J. Larner, p. 106.*
[32] *Robin Marris, p. 54.*
[33] *Brian V. Hindley, "Separation of ownership and control in the modern corporation,"* Journal of Law and Economics, *April 1970, pp. 185–221.*
[34] *Louis De Alessi, "Private property and dispersion of ownership in large corporations,"* Journal of Finance, *September 1973, pp. 842–843.*
[35] *Fritz Machlup, pp. 17–19.*
[36] *Louis De Alessi, pp. 842–843.*
[37] *Ibid., p. 843.*

seeking; we would probably call it 'mastery'—a desire to be in control of one's own fate, to be able to conduct affairs as one wished and to be good at it.

This motivational orientation subsumes most other needs as instruments for its achievement. Profit, for example, is a way of accumulating capital resources allowing an organization to make decisions partially independent of its customers.[38]

In general, Hunt concludes that R&D contractors are basically a "risk-averse group of firms. . . (that could) best (be) described as 'profit satisficers'."

In an experiment with sixteen undergraduates, Feeney, McGlothlin, and Wolfson of the Rand Corporation also found that the profits sought increased with uncertainty,[39] which again implies risk-averse behavior. It should be noted, however, that the motives of an organization can only be determined by inference—by studying its behavior or surveying the component members of the organization. It is the individual members that collectively define the motives of an organization. Consequently, an incentive must be perceived as a reward to the decision makers of the organization.

Hunt's work implies that incentive contracts can be written to accomplish that goal. However, in a 1973 postgraduate thesis, William Hill and Peter Shepard questioned whether incentive clauses really motivate middle managers. Finding no profit-maximization scheme in the seven companies they surveyed, they questioned whether profit incentives could be motivators.[40] But in another limited study, Julius E. Jones and Russell Pierre, Jr., found support for firm perpetuation and sales and profit maximization as the goals of the defense contractors.[41]

Peck and Scherer suggest that companies exhibit other nonprofit-maximization behavior such as maintaining unnecessarily large staffs to avoid the unpleasant task of laying off personnel.[42] It appears, then, that the nonprofit-maximization goals do apply to government contractors.

Therefore, it is essential to understand that the multiple goals of the DoD contractor—sales maximization, firm perpetuation, engineering staff and employee continuation, market share, research and development knowledge and expertise, technological innovation and base, risk reduction with long production runs, managerial job satisfaction, corporate image, employee relations, and supplier loyalty—will not necessarily raise the cost of the acquisition process. Figure 2 shows how price only partially satisfies the multiple goals of the decision makers. As can be seen, just the awarding of the contract to a firm will satisfy many of the managerial goals without regard to the level of profits as long as the profits are at or above the minimum satisfactory level.

The government's overall costs could even be lowered if the contracts could be written to satisfy one or more of these nonprofit goals. For example, multiyear contracting would enable the contractor not only to spread the overhead costs over a longer period of time, but also to increase the firm's perpetuation. This risk reduction could encourage the contractors to lower the level of satisfactory profit (and thus the price) on any one contract. In addition, the government could allow a contractor to build up a unique technology base that could be used for its defense as well as its commercial business if this meant lower overall costs to the government without creating a government sole source and a commercial monopoly.

Innovative contracting could also lead to less costly contracts. For example, Jack R. Runkle and

[38] *Raymond G. Hunt,* Extra-contractual influences in government contracting *(Buffalo, NY: State University of New York, 1971), p. 151.*

[39] *G.J. Feeney, W.H. McGlothlin, and R.J. Wolfson,* Risk-aversion in incentive contracting: an experiment *(Santa Monica, CA: The Rand Corporation, 1964), pp. 12–17.*

[40] *William Foster Hill and Peter Atwood Shepard, "Effectiveness of incentive contracts as motivators," Master's thesis, Naval Postgraduate School, 1973, p. 41.*

[41] *Julius E. Jones and Russell Pierre, Jr., "An analysis of the effectiveness and utilization of incentive contracts with respect to their intended purpose," Master's thesis, Air Force Institute of Technology, 1969, p. 80.*

[42] *Merton J. Peck and Frederic M. Scherer, p. 458.*

Figure 2. Government techniques to satisfy a firm's managerial goals

DIRECT RELATIONSHIP WITH CONTRACT PRICE
- Profit

INDIRECT RELATIONSHIP WITH CONTRACT PRICE
- Firm growth (employees, sales, assets, or profit)*
- Managerial perpetuation (keeping one's own job)
- Personal promotion and recognition

*Contract requirements and specifications may limit the fulfillment of this goal.

DIRECT RELATIONSHIP WITH THE AWARD OF THE CONTRACT
- Firm growth (employees, sales, assets, or profit)*
- Market share
- Using surplus capacity (employees, equipment, or facilities)*
- Share overhead of other products and projects*
- Technological improvements*
- Research and development
- Business base
- Business risk reduction*
- Diversification of product line
- Sales
- Patriotism

POSSIBLE INDIRECT RELATIONSHIP WITH THE AWARD OF THE CONTRACT
- Firm survival*
- Managerial perpetuation (keeping one's own job)*
- Personal promotion and recognition
- Personal utility
- Prestige
- Future commercial application*

Gerald D. Schmidt found that the frequency of evaluation meetings on award-fee contracts and the level of the fee determination officer are directly related to the firm's contract performance.[43] For little additional cost (primarily administrative expenses), the government could motivate managers and their firms without promoting excessive profits.

Since the profit motive is not the only theoretically correct objective of a firm, it is important that the government attempt to tap other goals in the acquisition process. Because managers generally attempt to avoid risk, the government could reduce firm perpetuation risk by authorizing multiyear contracts. Since managers attempt to satisfy personal needs such as prestige and job satisfaction, the government might be able to better meet these needs by conducting frequent reviews like the award-fee review process. Again, as the government attempts to meet these nonprofit goals, the total cost of the contract may be lowered since profit is not relied upon exclusively to motivate the contractor.

Over the last 15 years, a number of researchers have studied the effectiveness of incentives based on profit maximizing. The approaches used have been as rigorous as the data would support and as creative as the researchers could devise. Not one researcher has unequivocally supported the efficiency of using incentives to achieve the expected goals. Yet regulatory guidance continues to stress the profit motive.

While a proportion of contracts let in a competitive defense market may suggest the wisdom of a profit-maximizing approach, the preponderance of dollars awarded does not. In fact, a more balanced approach to DoD's profit policy is supported by the weight of evidence. DMJ

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[43] *Jack R. Runkle and Gerald D. Schmidt, "An analysis of government/contractor interaction as a motivator of contractor performance," Master's thesis, Air Force Institute of Technology, 1975, pp. 61–63.*

reports

Flexible management: a must for effective armed services recruiting

U.S. General Accounting Office, Washington, DC (September 1980)

The effectiveness of military recruiting programs is greatly influenced by policy and resource-allocation decisions made within the Office of the Secretary of Defense and the services' headquarters. This research effort suggests that if recruiting officials had increased flexibility to adapt policy and resource allocation to the changing conditions of market supply and demand, they could better reach recruiting goals and reduce recruitment-related irregularities.

According to the study report, a major obstacle to achieving recruiting goals is the inflexibility inherent in the management of service recruiting programs. This inflexibility is manifest in the absence of readily available nonmonetary policy alternatives that can be used as management tools within existing funding levels. Such inflexibility is sustained by the insistence that recruiting objectives can be fixed well in advance, despite the fact that the proper matching of recruiting resources and nonmonetary policies to these goals is generally not possible because of uncertainties regarding congressional action and the recruiting marketplace. Moreover, the requirement for all services to obtain congressional committee approval for spending additional recruiting funds through reprogramming hinders management's ability to quickly adjust its recruiting program to counter emerging problems.

The study recommends that recruiting managers be given the needed flexibility to relate resources to goals on a continuing basis. This would require that the Secretary of Defense monitor the services' implementation of recruiting objectives as stated in the Consolidated Guidance, related documents, and service program objective memorandums to determine if the guidelines are being interpreted with reasonable flexibility. The report suggests that the services be allowed to adjust objectives in response to changing market conditions. It also recommends that the Secretary of Defense direct each service to develop a formal plan concerning nonmonetary, standby enlistment initiatives that recruiting managers could use to adjust to changes in the recruiting marketplace. This plan should include:

- A variety of management initiatives, including unit-of-choice and accelerated-grade enlistment incentives and changes to standards and goals.
- A specific timetable that describes the circumstances under which these initiatives and incentives would be implemented.
- A description of the communication and total-force coordination process.

The study recommends that the Secretary of Defense direct the Army to improve the gathering and analysis of recruiting data pertinent to the National Guard and Army Reserve. This could be done by assigning more active Army professional staff and equipment or by transferring Reserve funds and personnel from other operations.

Finally, it is recommended that the Army and the Air Force further integrate their active, reserve, and National Guard decision-making activities. The long-term goal should be the combined recruiting management of all three components under a single manager in each service.

An appraisal of models used in life-cycle cost estimation for USAF aircraft systems

The Rand Corporation, Santa Monica, CA (October 1978)

By Kenneth E. Marks, H. Garrison Massey, and Brent D. Bradley

Life-cycle analysis—the examination of system capabilities and acquisition, operation, and support costs over the full life of a weapon system—has become an increasingly important and widely applied technique in Air Force system acquisition. Despite its widespread use, though, considerable uncertainty exists about the efficacy of life-cycle analysis as a management tool, particularly as an aid in evaluating acquisition and support trade-offs and making funding and other resource-allocation decisions.

The research reported in this study is intended to help system-acquisition managers cope with this uncertainty and to furnish them with a means of assessing the completeness and soundness of individual life-cycle cost estimates. The means provided is an evaluation of the most widely used life-cycle cost models: AFR 173-10 models (BACE and CACE); the Logistics Support Cost model (LSC); the Logistics Composite Model (LCOM); the MOD-METRIC model; AFM 26-3 Manpower Standards; Air Force Logistics Command Depot Maintenance Cost Equations; the Development and Production Costs of Aircraft model (DAPCA); and the RCA model for avionics development and procurement cost (PRICE).

The models were evaluated within a framework that incorporated a set of life-cycle elements representing a systematic breakdown of the different types of cost incurred over the life of an aircraft system and a set of cost-driving factors providing generalized means of dealing with various aircraft characteristics and operational and support concepts that influence cost.

The life-cycle cost elements were defined in terms of the Air Force program and budget structure within the general outline of the DoD aircraft cost element structure. The cost-driving factors include mission type, deployment mode, and maintenance concept, as well as reliability, maintainability, and physical characteristics of aircraft systems. The models were evaluated through examination of each driving factor-cost element combination and by assessing the ability of the models to predict the effect of a change in the driving factor on the cost element.

The cost models reviewed have substantial differences in intended use, coverage of cost elements, and strengths and weaknesses of their estimating techniques. The evaluations revealed few areas where the models, individually or in combination, are capable of producing reliable estimates of the absolute, incremental costs of a proposal. Moreover, it was found that there are many areas where the models provide no useful cost-estimating capability and that the most important driving factor-cost element combinations vary from one problem to another. Moreover, more than half of the relevant combinations are either not dealt with at all by the models or are handled in a manner that appears to be completely unrelated to the actual cause-and-effect relationships. Hence, in most cases the models cannot serve as a firm basis for life-cycle cost estimates without additional data and analyses.

Operation and support cost estimates produced by the models often serve only as relative cost indicators, resembling figures of merit rather than predictions of dollar costs that can be observed and measured. These figures of merit may be useful for examining relative comparisons of the operation and support costs of alternatives in some applications, but since their relationship to real operation and support costs is obscure, they are of limited help in determining whether an incremental investment is economically justified by future savings in operating cost.

Historical data in support of life-cycle cost estimates have been difficult to find, largely because the cost categories used in life-cycle cost models are incompatible with the functional and accounting categories used to record manning and cost information. The life-cycle element definitions developed for this research provide a means of alleviating much of that difficulty. Adoption of these definitions, or a similar set based on Air Force financial and resource management categories, could provide a sounder basis for estimates that can be realistically traced from initial estimate through full implementation.

In addition to the use of a single, well-defined cost-element structure, the other improvement in life-cycle cost modeling recommended by this report is improved sensitivity to cause-and-effect relationships. This requires both the identification of actual causal relationships between cost-driving factors and elements of cost, and the recognition that organizational, operational, and support concepts are important cost drivers. It is recommended that allocation methods that simply distribute costs in proportion to a convenient system characteristic be avoided. If life-cycle cost modeling is to be used to evaluate alternative designs, visibility at the subsystem and component levels is required. But the component-level visibility that is available in existing models should be combined with a more thorough consideration of the organizational, operational, and support policies that characterize a weapon system.

NAVMAN: a model for estimating maintenance personnel requirements for Navy aircraft

The Rand Corporation, Santa Monica, CA (June 1979)

By B. Armstrong and J. Schank

NAVMAN, a deterministic computer model that replicates present methods for Navy personnel planning for in-fleet aircraft, provides estimates of personnel requirements for preventive and corrective maintenance below the depot level on proposed aircraft systems. It also permits analysis of personnel-requirement consequences caused by changes in the flying program and in system reliability and maintainability.

Maintenance support of Navy aircraft is accomplished at three levels: organizational, intermediate, and depot. NAVMAN projects personnel needs for organizational and intermediate maintenance. Organizational maintenance involves those functions performed by an operating unit on a day-to-day basis, while intermediate maintenance involves off-equipment repair of assemblies as well as testing, calibration, and the manufacture of cer-

tain parts. Organizational maintenance is an aircraft-squadron function done with permanently assigned personnel; intermediate maintenance is performed by a ship crew or Naval Air Station group responsible for all aircraft and squadrons assigned to a carrier or air station. NAVMAN treats these maintenance groups separately with specific and individual input parameters, equations, factors, and tables.

To use NAVMAN, the analyst must supply operations information for both sea and shore environments such as sortie rate, sortie length, and flying days per week; organizational features such as squadron size, number of squadrons, aircraft type, and number of work shifts; and maintenance characteristics such as manhours per flying hour, mean time between failure, and mean time to repair. Model outputs are reported in ship requirements and shore requirements for each organization level, the total fleet, individual squadrons, and work centers.

The report suggests that several steps could be taken to strengthen and extend the NAVMAN model. The output of the model could be contrasted with squadron manning documents for which descriptive data are available. This would provide a more thorough validation of NAVMAN. Positive model extensions include making the number of squadrons a sensitivity variable and developing a subroutine to generate work-center maintenance workloads as a function of a wide range of reliability and maintainability inputs. The report contends that further improvement would result from a substantial broadening of the reference data base of historical reliability and maintainability values.

Consolidating military base support services could save billions

U.S. General Accounting Office, Washington, DC (September 1980)

In FY78, base support services such as payroll, transportation, building maintenance, and trash disposal cost the Department of Defense about $12 billion, or about 10 percent of its total budget.

Recognizing the potential for reducing base support costs, DoD established three major programs:

- The Defense Retail Interservicing Support Program, a DoD-wide effort to promote interservice consolidations among the military services.
- The Commercial and Industrial-Type Activities Program, an effort to contract for support services from private industry under the guidance of Office of Management and Budget Circular A-76.
- The Intraservice Support-Services Program, an initiative to consolidate support services within each service.

Through these cost-reduction initiatives, the services have made progress in meeting their objectives; however, progress has been constrained because DoD is reluctant to force consolidations on the military services and because military personnel at all levels are reluctant to let someone else provide their base support services. Although DoD has attempted to resolve this problem by implementing new procedures to escalate disputed consolidation proposals to the department level, the procedures have not been in effect long enough for their effectiveness to be measured. Nonetheless, it is believed that strong top-level leadership is needed to ensure that local interests do not frustrate proposed consolidations and to convince the services that consolidations can improve efficiency.

According to this report, a broad range of opportunities to reduce base support costs should be made visible to DoD. For example, the aforementioned interservice support initiative is a logical framework within which to provide the necessary visibility and to coordinate all cost-reduction efforts. Such coordination could help ensure that the best option, be it interservicing, intraservicing, or contracting, is chosen in each case.

Coordination could be improved by establishment of a single manager for military base support. This manager would have visibility over all base operating resources, thus alleviating much of the parochialism that has plagued attempts to reduce support costs.

The study report recommends that the Secretary of Defense strongly endorse a coordinated DoD effort to eliminate duplication of base support whenever mission effectiveness will not be impaired.

Specifically, it is recommended that the Secretary:

- Establish a focal point, preferably the DoD interservice program, to coordinate the three cost-reduction programs.
- Set specific annual cost-reduction goals for each military service and require each service to set a goal for its subordinate commands.
- Reduce base support funds for components that consistently fail to reach the above goals.
- Assign additional full-time staffing to the Joint Interservice Resource Study Groups.
- Direct each service to maintain cost data on the successes or failures of intraservice consolidations.

news summary

PATRIOT production begins

Buoyed by early test results, the Army has decided to begin limited production of the PATRIOT Air Defense System. A decision on full-scale production and subsequent European deployment will be made after tests on the early-production units have been completed.

The PATRIOT, the nation's most advanced ground air-defense system, is capable of engaging and destroying multiple aircraft simultaneously in a wide range of altitudes, during maneuvers and countermeasures, and in all weather conditions. The system employs phased array radar, a new and highly effective missile guidance scheme, together with a digital computer to achieve an unequaled level of air-defense capability. The Army plans for the PATRIOT to replace the capability of the NIKE HERCULES to engage high-altitude aircraft and much of the medium and low-flying aircraft mission of the Improved HAWK system.

Services to continue commissary operation

The Department of Defense has announced that the military services will be permitted to continue the operation of their respective commissary systems. This decision also established a permanent DoD Executive Board that will provide broad guidance on, set goals for, and evaluate the performance of commissary operations.

An examination of the feasibility of consolidating the commissary store systems into a single defense agency, initiated in April 1978, revealed a need for more effective DoD oversight of the operation of commissaries. These decisions are expected to strengthen the commissary systems and engender some of the more desirable aspects of consolidation without the creation of a new DoD agency.

The decision does not exclude consolidation as a long-term goal for future consideration.

Rules changed for veterans preference

Former members of the armed forces who retired at or above the rank of major or lieutenant commander and who are not disabled veterans are no longer eligible for veterans preference in competitive examinations and appointments. However, all disabled veterans regardless of rank, and those veterans who retired below the rank of major or lieutenant commander, will continue to receive preference.

The decision is based on the grounds that high-ranking, non-disabled veterans are fully equipped to compete for federal jobs on an equal footing with the civilian population. The change is contained in the Civil Service Reform Act of 1978.

Increases in sea and sub pay proposed

The Department of Defense will submit a legislative proposal to Congress to increase rates of sea-duty and submarine pay for Navy personnel. The $150-million benefits package will include increased bonuses for individuals entering nuclear career fields in the Navy.

The new proposal is designed to overcome the Navy's manning problems on surface ships and submarines. The higher pay also recognizes the particularly arduous nature of sea and submarine duty.

Variable housing allowance enacted

Members of the uniformed services who are entitled to a basic allowance for quarters (BAQ) will receive a variable housing allowance if they are assigned to locations where the average cost of housing exceeds BAQ by 15 percent or more. The VHA rules closely resemble the existing BAQ rules, but VHA will be figured on a daily-rate basis.

An individual's allowance rate depends only on the member's rank and military housing area as determined by the location of assignment. Each military installation, detachment, or recruiting station is included in one of the 347 military housing areas that have been established within the 48 contiguous states. Alaska and Hawaii are not included in the program since members assigned to these locations receive overseas station allowances.

The variable housing allowance is part of the Fair Benefits Package for the military services and was authorized in the Nunn-Warner legislation on the Military Personnel and Compensation Amendments of 1980.

Modernization of CH-47 helicopters to begin

The Army has awarded Boeing Vertol Company the first CH-47 helicopter modernization program production contract. The $103-million modernization contract contains funds for the remanufacture of nine CH-47A Chinooks to the new CH-47D configuration.

The Army determined that the remanufacturing of older Chinooks was the most cost-effective way to increase the flexibility of its medium-life helicopter fleet while lowering operating costs and extending fleet life.

news summary

Education benefits expanded

The Defense Department will conduct a one-year test of new and improved educational benefits for servicemembers who enlisted after November 30, 1980, but before October 1, 1981. The test will involve four separate programs.

The first is the nationwide Loan Forgiveness Program. To qualify for this program, soldiers must have had received either a Guaranteed Student Loan or a National Direct Student Loan after October 1, 1975. Under the program, Reserve enlistees will have 15 percent or $500 (whichever is greater) for each year of service subtracted from the loan. For active-duty soldiers, one-third or $15,000 (whichever is greater) will be subtracted for each year of service.

The second program, a new Educational Assistance Program, will be offered in selected parts of the country. To take part in this program, an enlistee must be a high school graduate, score at least 50 on the entrance verbal-math test, and enlist for a critical skill specialty. Benefits of the new Educational Assistance Program include a $1,200 tuition assistance account that will be adjusted each year, a $300 monthly allowance to be paid if the member is no longer in the military, authority to use the benefits after two years of service, and upon reenlistment, the authority to transfer earned benefits to dependents or take a 60-percent cash-out option. Members in this program cannot take part in the Veterans Educational Assistance Program.

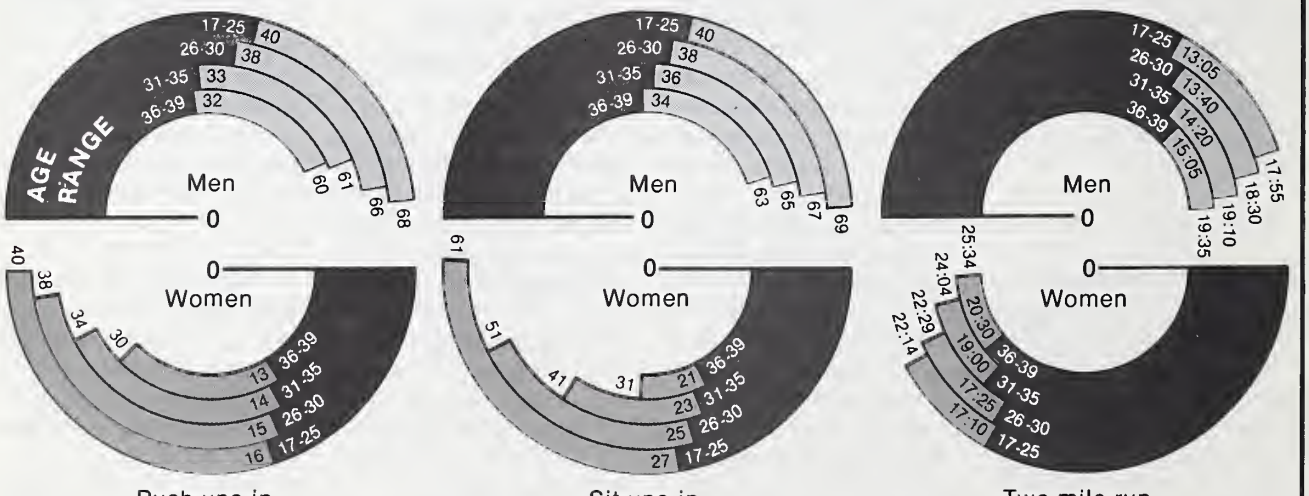
The third proposal, a Noncontributory VEAP, will be offered in certain parts of the country. It calls for DoD to pay servicemembers' contributions to the Veterans Administration. After three years of service, members in this program could save up to $8,000 in educational benefits. Additionally, the Army will offer VEAP kickers of $2,000, $4,000, and $6,000. Members of this program must also have a high school diploma, an entrance verbal-math score of at least 50, and choose training in a critical skill.

And lastly, the Army will offer a Super VEAP kicker in certain parts of the country. Eligibles must take part in the basic VEAP, enlist for a critical skill, be a high school graduate, and score at least 50 on the verbal-math test. Benefits include an $8,000 kicker for a two-year enlistment and a $12,000 kicker for a three- or four-year enlistment.

Army strengthens its physical readiness program

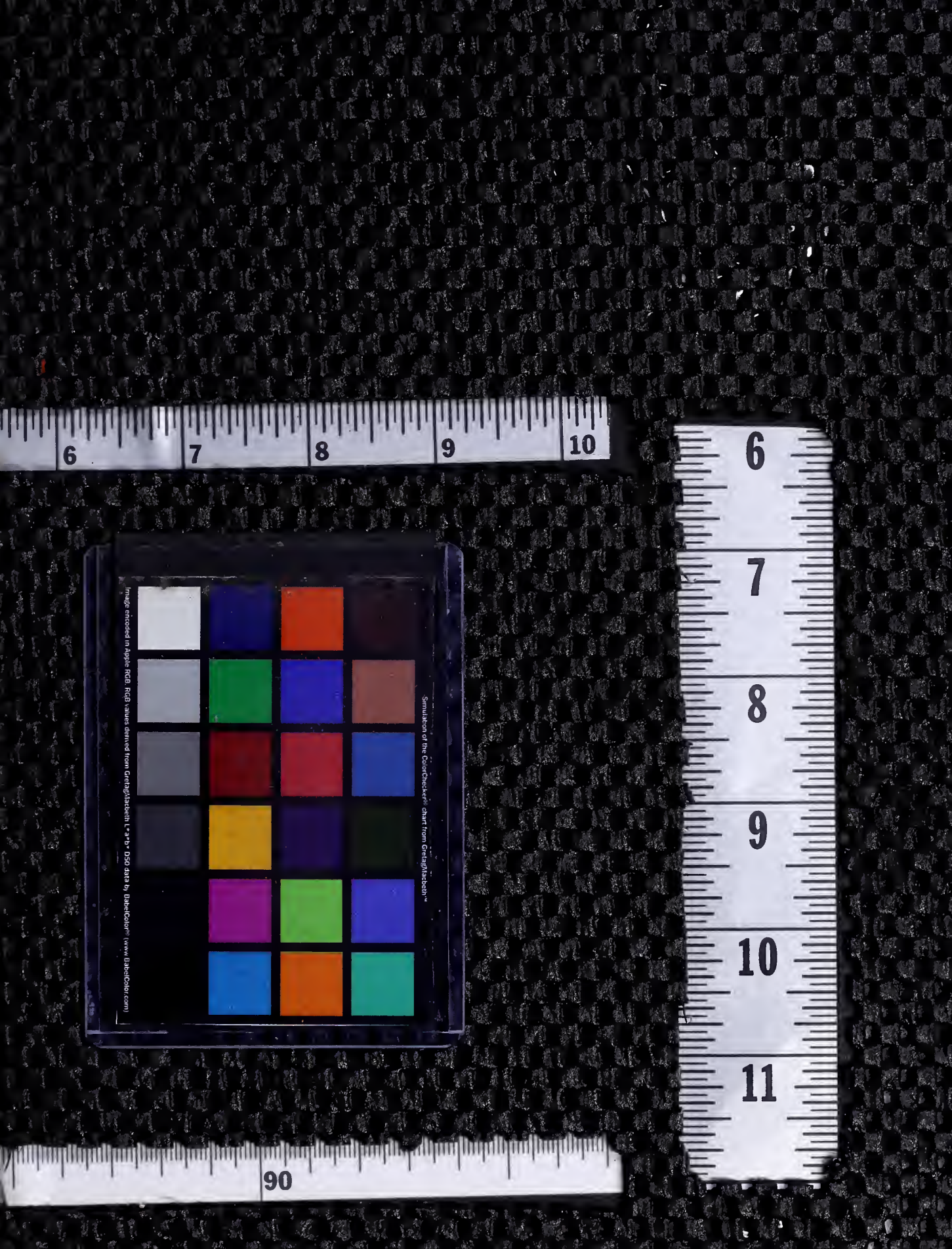
A change to the Army Physical Fitness and Weight Control regulation has established a new three-event Army Physical Readiness Test for personnel. All soldiers, irrespective of gender or type of assignment, are subject to the new fitness standards. Soldiers over the age of 40, however, are subject only to the two-mile run event, but only after medical clearance is received from an Army doctor. All soldiers will be tested twice a year, with at least four months between tests.

The bars indicate the minimum performance for passing the test and the maximum performance for scoring 100 points in each event. A soldier must pass all three events to pass the test.



calendar

Event	Date	Place	Contact
Developing Management Skills	Mar 10 Mar 11 Mar 12	Charlotte, NC Raleigh, NC Norfolk, VA	Human Development Seminars 5340 Central Ave. St. Petersburg, FL 33707 (813) 321-4600
Federal ADP Procurement	Mar 17–19	Washington, DC	NIMR Seminars Dept. DMJ P.O. Box 3727 Santa Monica, CA 90403 (213) 450-0500
Cost/Schedule Control Systems Workshop	Mar 25–27 Jun 22–24	Washington, DC Washington, DC	
Defense Resources Management Course	Mar 23–Apr 16 Apr 21–May 15 May 18–June 12	Monterey, CA Monterey, CA Monterey, CA	Defense Resources Management Education Center (Code 6401) Naval Postgraduate School Monterey, CA 93940 (408) 646-2104
Types of Contracts	Mar 26–27 Apr 23–24 Jun 1–2	Dallas, TX Alexandria, VA Boston, MA	American Graduate University/Procurement Associates, Inc. 733 North Dodsworth Ave. Covina, CA 91724 (213) 966-4576
Marketing, Pricing, and Management of Government Prime Contracts and Subcontracts	Apr 6–10 May 18–22	San Francisco, CA Boston, MA	
Modern Management and Supervision: Part I	Apr 6–10	Washington, DC	Special Programs Graduate School, USDA 277 National Press Building 529 14th Street, N.W. Washington, DC 20045 (202) 447-3247
Quantitative Approaches to Problem Solving	Apr 27–May 1	Washington, DC	
International Logistics Congress	Apr 12–15	San Francisco, CA	J.J. Addison SOLE P.O. Box 61353 Sunnyvale, CA 94088 (408) 742-6896
Innovation for Maintenance Technology Improvements Symposium	Apr 21–23	Gaithersburg, MD	National Bureau of Standards Mechanical Failures Prevention Group Washington, DC 20234
26th Annual Technical Meeting and Equipment Exposition	May 11–14	Philadelphia, PA	Registration Institute of Environmental Sciences 940 East Northwest Highway Mt. Prospect, IL 60056 (312) 255-1561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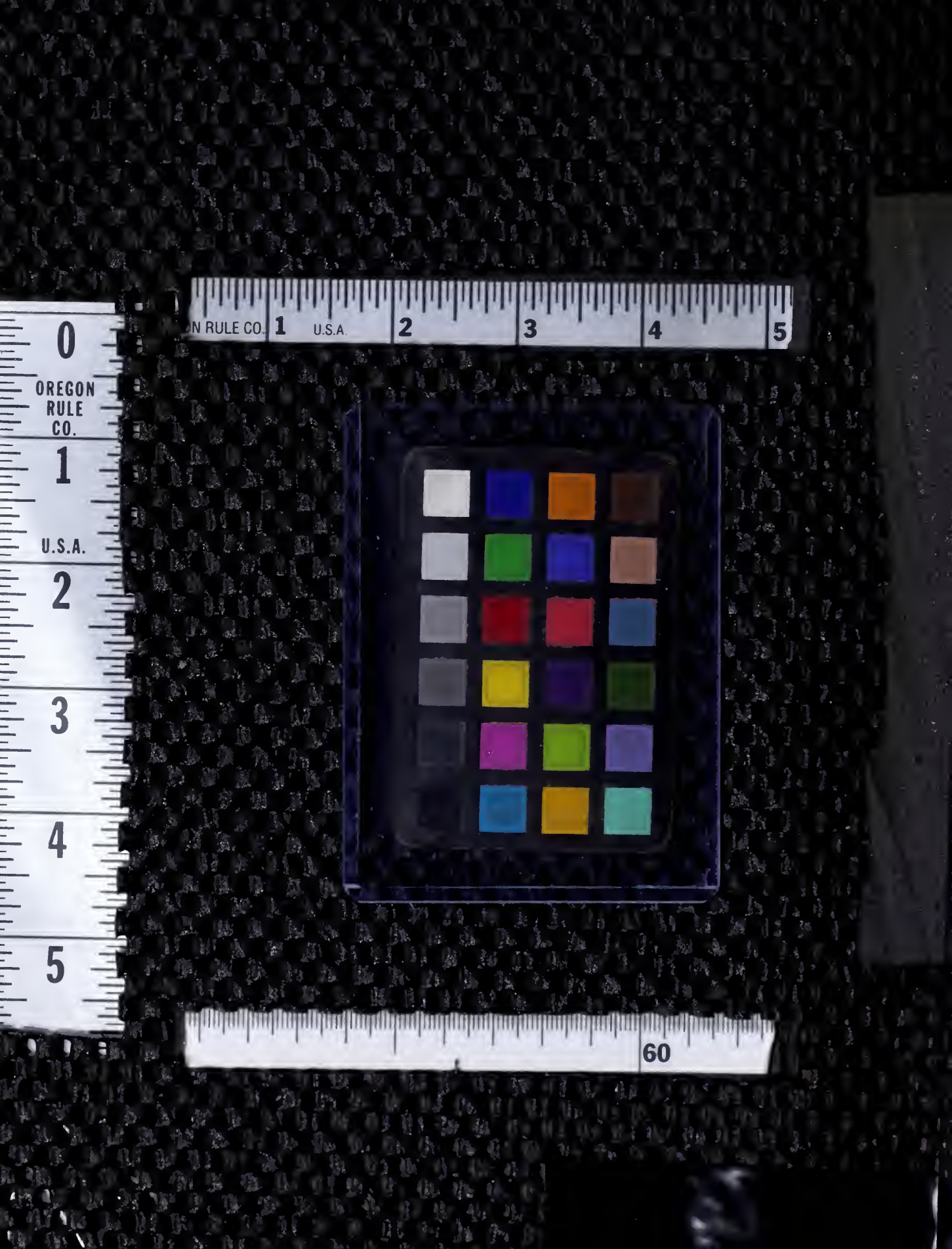
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